LONDINI *Sumptibus* Josephi Moxon.

The Catholique PLANISPHÆR:

Which Mr *Blagrave* calleth The

Mathematical Jewel;

Briefly and plainly diſcribed, in Five Books.

The firſt ſhewing *The making of the Inſtrument.*
The reſt ſhewing the manifold Vſe of it.

1. *For repreſenting ſeveral Projections of the* Sphere.
2. *For reſolving all* Spherical Triangles.
3. *For reſolving all Problemes of the* Sphere; Aſtronomical, Aſtrological, *and* Geographical.
4. *For making all ſorts of* Dials, *both without Doors and Within; upon any* Walls, Cielings, *or* Floores, *be they never ſo Irregular, where-ſo-ever the* Direct *or* Reflected Beams *of the Sun may come.*

All which are to be done by this Inſtrument, with wondrous Eaſe and Delight.

A Treatiſe very uſefull for Marriners, *and for all Ingenious Men, who love the* Arts Mathematical.

By JOHN PALMER. M. A.

Hereunto is added a brief Deſcription of the *CROS-STAF.*
And a *Catalogue of Eclipſes,* Obſerved by the ſame I. P.

The Heavens declare the Glory of God; and the Firmament ſheweth his Handi-work. Pſal. 19.

London, Printed by *Joſeph Moxon,* and ſold at his Shop on *Corn-hill,* at the Signe of *Atlas.* 1658.

To my Honoured Friend,

JOHN TWYSDEN

Doctour of *Physick*.

Sir,

MAny Learned Men have complained that Mr. Blagrave's Mathematical Jewel, (*as he calls it*) both the Instrument and the Book are rarely to be found. That the Book also by reason of the Interpolation of Gemma Frisius his precepts is longer then needed, and by reason of the Authors frequent interruptions by vexatious Suits in Law is somewhat confused; whereof himself complains in his Preface to the Reader, and in the Conclusion of the Fourth Book, and elswhere, wishing an amendment. At your request especially I undertook the reformation of that Treatise, which now at length I have finished. Gemma Frisius was the first that brought this Instrument to some good perfection, calling it Astrolabium Catholicum, but he did that by a Cursor and Brachialum which Mr Blagrave happily devised to perform by a Reet and Label, with more ease and delight. I have no designe to deprave the labours, or to obscure the Names or Fame of those ingenious Men, by whom this Instrument was contrived, and advanced to so great perfection; but as Mr Blagrave said when he took upon him to reform Gemma Frisius his Treatise; so I say of my last Edition of the Instrument after both, Facile est Inventis addore. Surely if men deceased have any knowledge or regard to what is done after them in this

World, and could have communication with thoſe that remain here, I ſuppoſe Mr Blagrave's *Ghoſt would give me thanks for doing that which he heartily wiſhed to be done but for want of leaſure left unfiniſhed: and I ſhould likewiſe thank him by whoſe means I became acquainted with this excellent Inſtrument: which, next to the* Sphear *or* Globe *it ſelf, is the beſt Inſtrument, in my judgement, that ever was deviſed for* Aſtronomy: *and for the eaſier making and portableneſs, is to be preferred before the* Sphear *it ſelf.*

My aime hath been throughout this Treatiſe to Write Plainly, Methodically, and with as much brevity as might conſiſt with perſpicuity, remembring that of the Poet, Brevis eſſe laboro, Obſcurus fio. *How far I have attained my Intention, the Reader will judge. If this work ſhall be found uſefull to the World, the thanks is due to you, who firſt ingaged me in it, and for the furtherance thereof took the pains to delineate the Inſtrument for me with your own hands, in Braſs Plates of fifteen inches Diameter; which I eſteem very highly, both for the exactneſs of the work, and for the work-man's ſake, to whom for more then twenty Years paſt I am alſo many other wayes obliged. I confeſs I have been ſomewhat ſlow in performing my promiſe to you, becauſe this Treatiſe hath taken up onely my ſpare hours, which by reaſon of infirm health, and more neceſſary emploiments, are not many.*

Sir, I am

Your Servant.

Ecton Apr. 1.
1658.

John Palmer.

The first book of the *Catholique Planiſphear.* Wherin

The whole Fabrick or making thereof is plainly Deſcribed.

Chap. I.

Of the parts of the Planiſphear. *And of the* Mater, *his matter and Lineaments.*

THis Planiſphere is made up of five parts
1 The lying plate, called *Mater.*
2 The moving plate; called the *Rete, Reet,* or *Net.*
3 The *Ring* or *Limb.*
4 The *Label.*
5 The *Sights.*

The *Mater* is a round plate of metal or paſt-board flat, ſmooth, and ſtiff: the larger the better. And if you will have the circles actually drawn for every degree, it had need be ten Inches at leaſt in Diameter. If it be made of metal (as Silver Braſs or Tin and Tin-glaſs in equal quantity melted together) it muſt be well polliſhed: but it may very well be made on a fair paſt-board, paſted on a Maſſie board: for thereon the Lineaments may be diſtinguiſhed with inkes of ſeveral colours, which cannot be if it be made in metall.

The Lineaments of the *Mater* (though they be fitted to re-

present other circles of the Sphear also, as shall be shewed, yet) most aptly represent the Meridians and Parallels: and therefore so we call them here, while wee speak of the *Fabrique*. Among the Parallels the two Tropiques and the two Poler circles are to be inserted. And lastly to these you shall add the Ecliptique: and so you have all the Lineaments of the *Mater*.

For the Declination whereof,

1 Upon the center of the *Mater* plate, describe the fundamental circle, (about an inch within the edge, if your plate be 12 inches Diameter) that so a convenient space may be left for the Limb. This circle shall be the great Meridian passing through the Poles of the world, and also through the *Zenith* and *Nadir* of your Countrey; and is the bound by which all the Lineaments of the *Mater* are inclosed. Draw two Diameters crossing one another in the center at right angles, and dividing this Meridian into his quarters, let one of these Diameters be A B the Axtree-line, the other C D the Equator or his Diameter: divide also every quarter of this Meridian into 90 equal parts or degrees.

This Meridian onely of all the circles of the *Mater*, falleth out to be a full circle in this projection, because the bisection of the Sphear is supposed here to be made in the plain thereof, and because the eye is supposed to be the Pole thereof, and so equidistant from every part thereof. The rest of the Meridians and Parallels their Semicircles are in this *Planisphere* fore-shortned according to Optique reason, (as shall be further explained Ch 2) because they all either are great circles passing through the eye-point, and cutting the Meridian at Right angles, as the Axtree-line or East Meridian, the Equator, and the Ecliptique, which are therefore projected upon their Diameters and become straight lines; or else lie Oblique to the eye, as do all the rest of the Meridians and Parallels, which are all of them projected into arches less then a semicircle; and yet every one of them is to be accounted a semicircle fore-shortned, and to be divided as a semicircle into 180 degrees.

2 To describe the rest of the Meridians, you shall lay a Ruler from the Pole A to the several degrees of the semicircle C B D (or from the Pole B to the several degrees of the semicircle

cle C A D, for all comes to one) and mark where the Ruler intersects the Equinoctial line C D for every degree; so shall you have the Equinoctial divided into 180 deg. (*viz.* 90 degr. on one side the center, and 90 degr. on the other) through which divisions or degrees the severall Meridians shall pass, and all of them must meet in both the Poles. Therefore having three points given for every Meridian (*viz.* the two Poles A and B, and a middle point in the Equator C D, bring these three points into a circle, and you shall have the true arch of every Meridian drawn on the Planisphear; as they appear in this Projection: which how to do shall be further shewed Chap. 3.

3 To describe the Parallels, you shall first divide the Axtree-line A B into 180 deg. (as you divide the Equator C D) by laying your Ruler from C or D to the several degrees of the opposite Semicircle, and marking where the Ruler intersects the Axtree-line A B; or with your Compasses transfer the division of the Diameter C D to the Diameter A B; so shall you have three points given for every Parallel, whereby his arch may be drawn: as for example, the tenth Parallel North shall be drawn from the tenth degr. of the Quadrant D A, counted from D, by the tenth division of the Semidiameter E A, counted from E, to the tenth degr. of the Quadrant C A, counted from C: and so of the rest. The Tropiques and Poler circles are described as the Parallels. Yet of them see Chap. 6.

4 To describe the Ecliptick, number his greatest Declination (23 degr. 30 mi.) in the Meridian from C, towards A to F, and again from D toward B to G; then joyn the points F and G with a straight line which shall pass through the center of the *Mater* and be the Ecliptick. For dividing whereof you shall only transfer the division of the Axtree-line or Equator upon this Ecliptick line (for all Diameters have like divisions) and you shall distinguish every tenth and 30 degr. by longer stroaks, and shall set ♑ at G; ♈ and ♎ at the center; ♋ at F: and the rest in their order.

Chap. II.

Of the reason of this Declination.

For the better understanding of the reason of this Declination, either take or suppose to your self an hollow Sphear or

Globe, of equal diameter with your great Meridian before drawn. Cut this Sphear by the Meridian into two diſhes or Hemiſphears, the one repreſenting the Eaſtern, the other the Weſtern Hemiſphear of the Heaven: So in each of theſe Hemiſphears the Meridian is an whole Circle, being the Baſe of the Hemiſphear, or brim of the diſh: but the reſt of the Meridians, the Parallels, Equinoctial, and Ecliptick, are all biſected by the great Meridian, and ſo you can have but half their circles in the Eaſtern Hemiſphear, and the other half is in the Weſtern.

Next ſuppoſe alſo the plain A C B D, to be a thin plate of ſome tranſparent matter, as clear horn, glaſs, or chriſtal; and this plate fitted to ſtick in the diſh mouth (that is, in the Meridian of the Hemiſphear) and upon the center E a ſtraight wyre to be erected perpendicular to the plain A C B D, and the length of the ſaid wyre to be equal to the ſemidiameter E A. Now place your eye at the top of this wyre, and look up the Lineaments of the Hemiſphear through the glaſs plate, and obſerve where the viſual lines drawn from the ſeveral points of the Hemiſphear to the eye cut the glaſs, and what kind of lines and arches they do paint upon the glaſs, and you ſhall ſee there that the ſemicircles of the Equator, the Eaſt Meridian, and the Ecliptick, will be depainted on the glaſs in ſtraight lines, becauſe they be great Circles, and paſs through the eye-point of this projection) and the lines paſſing between your eye and the ſeveral degrees of any of them ſhall divide their Diameters upon the glaſs into ſuch parts, as they are divided by the precept of the former Chapter. For the top of the wyre (here ſuppoſed to be the Weſt point of the Horizon) is the true eye point from which the Diameters A B and C D are divided, and from which the whole projection of the Eaſtern Hemiſphear is made at one view upon the glaſs. But becauſe this concave Hemiſphear with his wire or Axis erect, cannot eaſily be pictured on a flat, therefore to ſupply the want of a ſolid Scheme you may conſider that the Axtree line A B is not onely the Diameter of the Eaſt Meridian, but a common Diameter to all the Meridians: and therefore if you take your eye point at C or D, and by your eye beam or a ruler laid from one of thoſe points to all the degrees of the oppoſite ſemicircle do divide the Axtree line, it ſhall be all one as if you had divided him from the top of the wire by the degrees of the Eaſt Meridian which paſſeth through the bottom of the concave Hemiſphear. For all great Circles

Circles of the Sphear and their Diameters likewise being equal, look how any one of their Diameters is divided, in like manner they shall all be divided, if the eye be alike situate to them.

Chap. III.

How to find the centers of the Meridians *five several wayes.*

The centers of the Meridians and their semidiameters are thus found,

1. You have by the first Chap. three points given, by which they must be drawn (*viz.*) the two Poles, and a third point in the Equator) and how to bring these into a circle or arch, is shewed by *Enclid.* 4, 5. But I think this way incomodious for this purpose.

2 A better way is to get the centers by proffers, thus, Let it be required to draw the twentieth Meridian whose points given are A 2 B. Having first extended infinitely the line C D, set one foot of your Compasses at adventure, in the line C D, whereabout you gues's the center should be, and extending the other foot to A or B, carry it about at the same extent towards 2, and if it touch the point 2, you have taken the true center, and may draw the arch as is required, if your Compas's overreach, you must narrow it, and come nearer; if it reach short, widen your Compas's, and seek your center further, till by tryal you light upon it: if one foot of your Compas's stand in the line C D, and the other cut the middle point, and one of the extream points A or B, it ought to cut the other also; if your plain be flat, and the line C D straight and square to the line A B: but if any of these have failed, you shall never bring the three points into an arch while the foot of your compas's standeth in the line C D. Therefore in such case set one foot in A, and draw with the other foot a short arch croffing the line C D; then set the standing foot in B, and with the running foot cros's the short arch last drawn: where these arches cros's will be the center, by which you may draw an arch cutting A and B, and if it cut 2 also, you have your desire. But if this arch over reach 2, widen your Compas's: if it

come short of 2 (the middle point) narrow your Compass, and try again in like manner till you can compass all the three points in the same arch.

3. A third way. I suppose you may know that every Meridian cuts the Equator twice, *viz.* in two opposite points distant 180 degr. one from another: as, for example, the Meridian which cutteth the Equator in 60 degr. of Right Ascension, cuts it again in the opposite degr, *viz.* 240. Now if you can find these two points in the Equator line C D, the center will be in the just middle betwixt them. One of these points is already given within the fundamental Circle; the other without, is thus found. Prolong your Equator infinitely beyond your plate both wayes, and divide the extension thereof by like reason as you divided his Diameter, *viz.* as by a Ruler laid from A to the several deg. of the Quadrant B C, you devided the Semidiameter E C into 90 degr. so keeping still one end of your Ruler fixed at A, and carrying about the other end thereof to the severall degrees of the Quadrant C A, you may divide the excurrence of the line E C into 90 degr. more: and so E C and his exccurrence or continuation will be half the Equator divided into his degr. and E D with his excurrence on the other side will be the other half divided by like reason. And thus the whole Equator is projected in one straight line, and divided into degr. also. Then having a point given within your fundamental circle through which the sixtieth Meridian must pass (*viz.* the 60 deg. of the Semidiameter E C or E D) number thence over the center to 180 deg. and there is the point where the other semicircle must cross, and the middle between those points is the center. But because the two points taken in the quadrant A C are very near together, especially towards A, and the Ruler also will cross the prolongation of the line E C very obliquely, you may therefore do better to divide this line into his degr. by a Scale of Tangents, for if upon the Equinoctial line D E C you prick down from E both wayes the Tangents of the half degr. in order from 0, to 90, those pricks shall be the whole degr. of the Equinoctial line in this Projection, to be numbred from E both wayes to 180 deg. where the Tangent becomes infinite. Thus taking A E for Radius, E D is the Tangent of 45 deg. by the structures: yet the arch or Diameter E D is a Quadrant or 90 deg. of the Equinoctial in this Projection, because

the

the Tangents of the half deg. of the Quadrant E A I, measure out the whole degr. of the line E D, as was above-said.

4 If you consider well what hath been said, you will find (or you may take it here upon trust,) that for the 90 Meridians to be drawn between C and E, half the centers will be found in the opposite Semidiameter E D, and the other half without D in the said Semidiameter prolonged. And that every second division of the line E D from E toward D and forwards, shall be the centers of the Meridians which cut the Semidiameter C E. As for example, to draw every fifth Meridian from C to E, you take every tenth deg. from E toward D for the centers.

And further if you would not be at more trouble then needs, to divide the extension of the Diameter beyond the fundamental circle, you shall but do thus. Begin with the crookedest Meridians first, whose centers are within the fundamental Circle, and first pitching one foot of your Compass in the point 1, (near E) extend the other foot beyond the center to 2; there is the center from which you shall draw the first Meridian A 1 B: and also turning about your Compass you shall make a marke in the extension beyond D at 1, where the other Semicircle of this Meridian would cross the Equator. So for the next Meridian, in the line C E marked with 2, your center is beyond E at 4, and after you have drawn his arch A 2 B, marke with your compass his other crossing at 2 beyond D, and so with one labour you shall both draw the 45 crookeder Meridians, and also make the out lying division of the line E D prolonged: of which division every second or even number will be a center to some of the straighter Meridians. This is a very good and easie way: and this way Mr *Blagrave* alwaies used.

5 Or lastly You may frame a decimal Scale of 1000 or 10000 parts, equal to the Semidiameter of the *Mater*; by which Scale with the help of the Cannon of Triangles, you may presently find the length of any S ne Tangent or Secant you shall desire. Now look what inclination any Meridian hath to your fundamental Circle (that is, what angle they make between them) the Secant of that inclination is the Semidiameter of that Meridian; and the Tangent of the same inclination is the distance of his center from E the center of the *Mater*. For example, the Meridian A 2 B his inclination is 20 deg. (for the angle C A 2 and likewise the arch C 2 which measures it is 20 degr. the S cant of 20 degr is 10641.

10641. by the Cannon of Triangles (which every Mathematician ought to have at hand) Take with your Compasses from your decimal Scale 10641. and setting one foot in A, with the other foot cross the Semidiameter E D; in that crossing is the center: or take with your Compasses 3639. the Tangent of 20 degr. and set it from E toward D, and it shall give you the same center at 4. For A E being Radius, E 4 is the Tangent, and A 4 the Secant of 20 deg. by the structure.

And if you like to work this way, it will help you much to have a short Cannon of Tangents and Secants of whole degr. of the Quadrant gathered into one page: which Cannon for your ease is here annexed.

A Table of Tangents and Secants to every degree of the Quadrant.

Degr	Tan.	Secan	gr	Tan.	Secan	Degr	Tan.	Secan
1	00174	010001	31	06008	011666	61	18040	020526
2	00349	010006	32	06248	011791	62	18807	021309
3	00524	010013	33	06494	011923	63	19626	022026
4	00699	010024	34	06745	012062	64	20503	022811
5	00874	010038	35	07002	012207	65	21445	023662
6	01051	010055	36	07265	012360	66	22460	024585
7	01227	010075	37	07535	012521	66·30	22998	025078
8	01405	010098	38	07812	012690	67	23558	025693
9	01583	010124	39	08097	012867	68	24750	026694
10	01763	010154	40	08390	013054	69	26050	027904
11	01943	010187	41	08692	013250	70	27474	029238
12	02125	010223	42	09004	013456	71	29042	030715
13	02308	010263	43	09325	013673	72	30776	032360
14	02493	010306	44	09656	013901	73	32708	034203
15	02679	010352	45	10000	014142	74	34874	036279
16	02867	010402	46	10355	014395	75	37320	038637
17	03057	010456	47	10723	014662	76	40107	041335
18	03249	010514	48	11106	014944	77	43314	044454
19	03443	010576	49	11503	015242	78	47046	048097
20	03639	010641	50	11917	015557	79	51445	052408
21	03838	010711	51	12348	015890	80	56712	057587
22	04040	010785	52	12799	016242	81	63137	063924
23	04244	010863	53	13270	016616	82	71153	071852
23·30	04348	010904	54	13763	017013	83	81441	082055
24	04452	010946	55	14281	017434	84	95143	095667
25	04663	011033	56	14825	017882	85	11430	114737
26	04877	011126	57	15398	018360	86	14300	143355
27	05095	011223	58	16003	018870	87	19081	191073
28	05317	011325	59	16642	019416	88	28636	286537
29	05543	011433	60	17320	020000	89	57289	572986
30	05773	011547				90		

Chap. IIII.

To find the Centers of the Parallels, six several wayes.

THe first way, but the worst for our purpose, (as was said before for the Meridians) is by the fifth Proposition of the fourth book of *Euclid*; to find the Center of the Circle circumscribing the Triangle made by the three points given.

2 A better way is by profers. Take this upon trust: that as you found the Centers of all the Meridians in the Equator, so shall you find the Centers of all the Parallels in the Axtree line prolonged, and by making like profers as you were taught for the Centers of the Meridians, (Chap. 3.) you may quickly find the Centers of the Parallels.

3 A third way. You must consider that the Axtree line represents the East Meridian as well as the Axis of the world which is a common Diameter to all the Meridians. Also that every Parallel cuts the East Meridian (as it doth the rest) in two points Equidistant from the Equinoctial and two Equidistant also from the Poles. Therefore having one point already given in the Axtree line within the fundamental Circle where the Parallel shall cut, number the distance from this point to the next Pole, and number also the same distance again beyond the Pole in the Axtree-line prolonged, (being divided also as you were taught to divide the Equator line Chap. 3. and at the end of this number shall the Parallel cut the Axtree line again. And the middle between these two sections is the Center. For example, the 50th Parallel is 40 degr. distant from the Pole. Count therefore in the Axtree line prolonged 40 degr. beyond the Pole, and there is the utter end of this Parallel's Diameter; which if you part in two, the middle at G is the Center.

4 If from the point given, where the Parallel cuts the great Meridian, you raise a Tangent line, this Tangent shall cut the Axtree line in the Center of the Parallel. Example, The said 50th Parallel cuts the great Meridian at H, there I raise the Tangent H G perpendicular to the Radius E H. And this Tangent as you see cuts the Axtree line in G the Center of the Parallel.

5 Hence ariseth a fifth way. For it appears by this figure

that the Tangent of the Parallels distance from the Pole is equal to his Semidiameter: and that the Secant of his distance from the Pole is equal to the distance of his Center, from the Center of the great Meridian. For here E H is Radius, H B an arch of 40 degr. H G the Tangent thereof, and Semidiameter of the Parallel, E G the Secant thereof, and the distance of the Center of the Parallel from the Center of the Meridian. And all this is evident by the structure in the Scheam. Wherefore making E H Radius, take from your Scale or Sector, with your Compasses the Secant of the Parallels distance from the Pole, and set it from E in the Axtree line, and it shall end in the Center of the Parallel. Or take the Tangent of the Parallels distance from the Pole, and set it from the point of his Section with the Meridian toward the extension of the Axtree line, and where the end of it just toucheth the Axtree line, there is the Center.

6 For want of a Sector, or other fit Scales of Tangents and Secants you may do thus: Set one foot of your Compass in the Center E, and extend the other upon the Diameter of the Equator or Axtree line, to twice so many degr. as your Parallel is distant from the Pole. That distance is the very Tangent you seek. For example, for the 40th Parallel from the Pole, I number from E toward D 80 degr. to 8. now E 8 is the Tangent of 40 degr. (though it contain just twice so many degr. of the Circle foreshortned in this projection, as hath been shewed Chap. 3. Sect. 3.) and so if you will have the Secant of 40 degr. take with your Compasses the length from 8 (where the Tangent ends) to A. and that is the Secant to be used as was taught in the last Section.

Thus have you wayes enough for finding the Centers of the Meridians and Parallels. And you may have occasion in the making of the Instrument to use most of them one time or other. However, the knowledge of them is both pleasant, and usefull for the right understanding of this and other Projections of the Sphear, as also for the examination of your work, when you shall chance to doubt of it.

CHAP.

CHAP. V,

How to draw the straighter Meridians *and* Parallels, *whose Semidiameters are very long.*

IT may trouble you very much to draw those Meridians and Parallels which lie near to the Diameters; because they be arches of great Circles, and require Compasses larger then you can well get, or manage when you have gotten them. Till you come to the 80th Meridian from the Limb, a Beam-compas of a yard long will reach, if your *Mater* be not above a foot Diameter, and a longer Beam you cannot well manage, for it will be apt to tremble with it's own weight, and draw double lines, though it be made very thick and massie. But the 89th Meridian will require a Beam-compas of almost ten yards long: For his Semidiameter will contain the Semidiameter of the great Meridian 57 times. Therfore to draw the 10 last Meridians and the 10 last Parallels, you may help your self one of these wayes.

1. *Guido Ubaldus* hath devised an Instrument for this purpose, consisting of three rulers in form of an obtuse Triangle. The description and use thereof you may see in *Blagr. l.4.c* 2,3. and in *Ubaldus* his book *De Theorica Astrolabij*. But though it be an Ingenious device, yet I have found by experience, that it is a tickliish Instrument, and hardly managed, for which reason I have hanged it by.

2 The Bow now commonly used, is an Instrument not so artificial, but more tractable and steddy then the former. It is made of too steel rulers, the shorter of them must be of good substance, as three quarters of an inch in heighth, and as much in breadth, that it may be stiff, and lie flat; the length must be somewhat more then the Diameter of your Instrument: The other may be an inch longer, of the same heighth but much narrower, that it may be bent out with screws into an arch of any Circle required; which ruler so bent, being laid to the three points given, you may by it draw the arch required, as easily as you draw a straight line by a straight ruler. The stiff ruler carries the screws, and it must have rivets, by which the bending ruler may be staied at both ends, while it is bent by the screws. See the figure.

CHAP. VI.

How to draw the Tropiques, *and* Polar *Circles, and to finish the* Mater.

BEsides the 180 Parallels abov ementioned, you have four more to draw before the *Mater* is finished, *viz.* the two *Tropiques*, and the two *Polar* Circles; of which the Northern is called the *Arctique*, and the other the *Antarctique* Circle. How to draw these you are sufficiently instructed Chap. 4. if you know but their Declination, for they be Parallels. The *Tropique* of *Cancer* declineth from the Equator toward the North Pole 23 degr. 30 min. and the *Tropique* of *Capricorn* declines as much toward the South Pole. The *Arctique* Circle declines Northward 66 degr. 30 min. and the *Antarctique* as much Southward. And these being drawn after the manner of the other Parallels, you have drawn all the lineaments of the *Mater*, And the better to adorn and distinguish them, you shall with your Graver hatch every fifteenth Meridian: for they are hour lines. The South arch of the great Meridian A C B is the hour of Noon: and his North arch A D B, the hour of Midnight. These need not be hatched, being the Semicircles of the great Meridian, or fundamental Circle, which contains all but the Axtree line A E B, which is the hour line of the fixes, and the rest of the hour lines counted from him both waies, would be hatched on both sides, to shew like a ragged staff, for distinction sake. Also every fifth Meridian (not being a fifteenth) you shall make a pricked line, not punching it with a round point, lest you make your plate warp, but making many short strokes cros the line with your Graver, which will be more conspicuous. Every tenth Parallel also would be a ragged line, and the intermediate fifths pricked lines: likewise the *Tropiques* and *Polar* Circles would be pricked lines. Also if your plate be large, you may set figures to the hour lines, and to every tenth Meridian at the Equator: but if your plate be smal the divisions of the *Label* applied upon the Equator may supply the lack of them.

CHAP.

Chap. VII.

Of the Reet, *or* Net.

HAving shewed you what belongs to the Fabrique of the first part of this Instrument called the *Mater:* A few words more will instruct you how to make the *Reet*, whose lineaments are for the most part the same.

The *Reet* is a round plate of metal, or pastboard, like unto the *Mater*, but of less Diameter: it must be well planished and polished; and the thinner the better, if it hold working it would not be thicker then a shilling, being of a foot Diameter. It is called the *Reet* or *Rete*, that is the *Net*, because it must be pierced through, and made like unto a *Net* or Lettess; that the lineaments of the *Mater* may be perceived through it. If we had a transparent metall, much labour might here be saved. A clear Lanthorn horn may serve for a smal Instrument, but for large Instruments, it is best to have it either of fine pastboard, or, if you will go to the cost, of metal cancelled; as shall be taught.

1 For the delineation of the *Reet*, first draw your fundamenttall Circle equal to the fundamental Circle of the Mater, leaving a border or Limb without, of such breadth as may receive the graduations of the Circle, and figures set to them, which breadth may be three tenths of an inch, where the *Reet* is a foot in Diameter: draw likewise two Diameters A B, and C D, crossing one another in the Center E at right Angles, and dividing the Circle into his four Quadrants, which you shall subdivide again into 90 degr. apeece, as you did in the *Mater*.

2 You shall inscribe two arches, which shall represent the Semicircles of the *Ecliptique*, which shall meet at the points C and D of the Equator, and the middse points of these arches shall be found in the Diameter A B, thus. The Diameter A B being divided as before you were taught to divide the Diameters of the *Mater*, number from A toward the center E 23 degr. 30 min. and there make the point F, for ♈: and likewise number from B toward E 23 degr. 30 min. and there set the point K, for ♎, then join the points C F D in one arch, and the points C K D in another arch (as is taught Chap. 3) and your *Ecliptique* is drawn. But now you must make him a narrow *Limb* inward toward the

Center, to receive the scale of his degr. and the characters of the Signes. And to divide him you shall do thus. Number in the Axtree line (A B, from F inwards 90 degr. there is the Pole of the arch C F D, to this Pole fasten one end of your ruler (having an ey-lid-hole in the edge for that purpose) and carrying about the other end over the several degr. of the Semicircle C A D, you shall cut the arch C F D into his correspondent degrees. As if you lay the ruler from C to 10 degr. in the *Limb* toward A, it shall cut the *Ecliptique* in ♎ 10, and so of the rest. Likewise for the other Semicircle C K D, find his Pole 90 degr. from K toward F and A: and from that Pole by like reason, you shall divide the Semicircle C K D by the divisions of the Semicircle C B D. This is the best way.

Or you way divide the *Ecliptique* by a Table of Right Ascensions, thus. Lay your ruler from the Center E to 27 deg. 54 min. in the *Limb*, which is the Right Ascension of ♓ 0. to be counted from D towards B, and the ruler shall at the same time cut the *Ecliptique* in ♓ 0, to which that Right Ascension belongs, and so for any other deg. or you may defer the dividing of the *Ecliptique*, till you have finished and cut out the *Reet*: and then if you set the line C D of the *Reet*, in A B the Axtree line of the *Mater*, the *Ecliptique* will lie among the Meridians of the *Mater*, and shall be so divided by the Parallels of the *Mater*, as the Meridians are divided by them. But my advice is that you divide your *Ecliptique* the first way, and you may use this for proof of your work at last.

3 The rest of the lineaments of the *Reet* are the *Azimuths*, to be drawn as the Meridians of the *Mater*, and the *Almicanters*, to be drawn as the Parallels. Onely you shall need to draw but half the *Almicanters*, and the *Azimuths* but half way, leaving one half of your *Reet viz.* E C B D blank and void of them.

In drawing these *Azimuths* and *Almicanters* you shall be carefull to skip over the border of the *Ecliptique*, leaving it fair, that the graduations thereof with their figures set to every tenth degr. and the characters of the Signes may be more distinctly seen. Also you shall do well, if you make a border to the Axtree line on the Northside, that is toward D, and let this border be of the same breadth from A to B, the breadth not exceeding one fifth of an inch in a *Reet* of a foot Diameter; upon which border you may make a scale of degrees, setting figures in it to every tenth

Almi-

Almicanter. This will be a great strength and Ornament to your *Reet*.

Below the Horizon C D likewise, you shall make a *Limb* or border for the Horizon, to receive his graduations: this may be a quarter or three tenths of an inch broad, where the *Reet* is a foot in Diameter: and upon this border you shall set figures at every tenth *Azimuths*, and shall number them both wayes, from the Center and from the Meridian.

4 You shall inscribe so many of the fixed Stars as your *Reet* may well receive. Which to do you must know their Right Ascensions (or Culminations) and also their Declinations, for which purpose I have given you a Table of 110 of the more notable fixed Stars, (which may best be inserted in your *Reet*,) with their Right Ascensions and Declinations calculated to the year of our *Lord* 1671. which may serve for 40 years before and after without any considerable error.

To inscribe them you shall first number the Right Ascension of the Star from ♈ 0, that is from D upon the *Limb* of the *Reet* toward B, and at the end of that number fix your *Label*, (which by this time should be made and pinned on the Center,) then from the *Limb* count inwards upon the *Label* the Stars Declination, and at the end of that number make a prick in your *Reet* close to the edge of the *Label*, there is the Stars place. Then with your Graver you shall make there the shape of a Star, with 4, 5, or 6 points, according as the magnitude of the Star deserves: and let one point be longer then the rest; and let it point outward from the Center, if the Stars Declination be North, but inward toward the Center, if his Declination be South: and let the end of his long point (called *Apex*) be in the very true place of the Star. But if your *Label* be yet unmade, then take the measure of the Stars Declination with your Compasses upon any of the four Semidiameters of the *Reet*, (measuring it from the *Limb* inwards,) then lay a ruler from the Center to the Right Ascention of the Star, and where the ruler cuts the *Limb* of the *Reet*; there set one foot of your Compasses, (opened as before) and with the other make a prick toward the Center, close to the edge of your ruler, and there is the Stars place in your *Reet*.

5 Lastly, you shall cut out all the spaces of this *Reet*, which may be spared; remembring alwaies that you leave uncut the borders of the *Ecliptique*, Horizon, and Axtree line, and be very care-

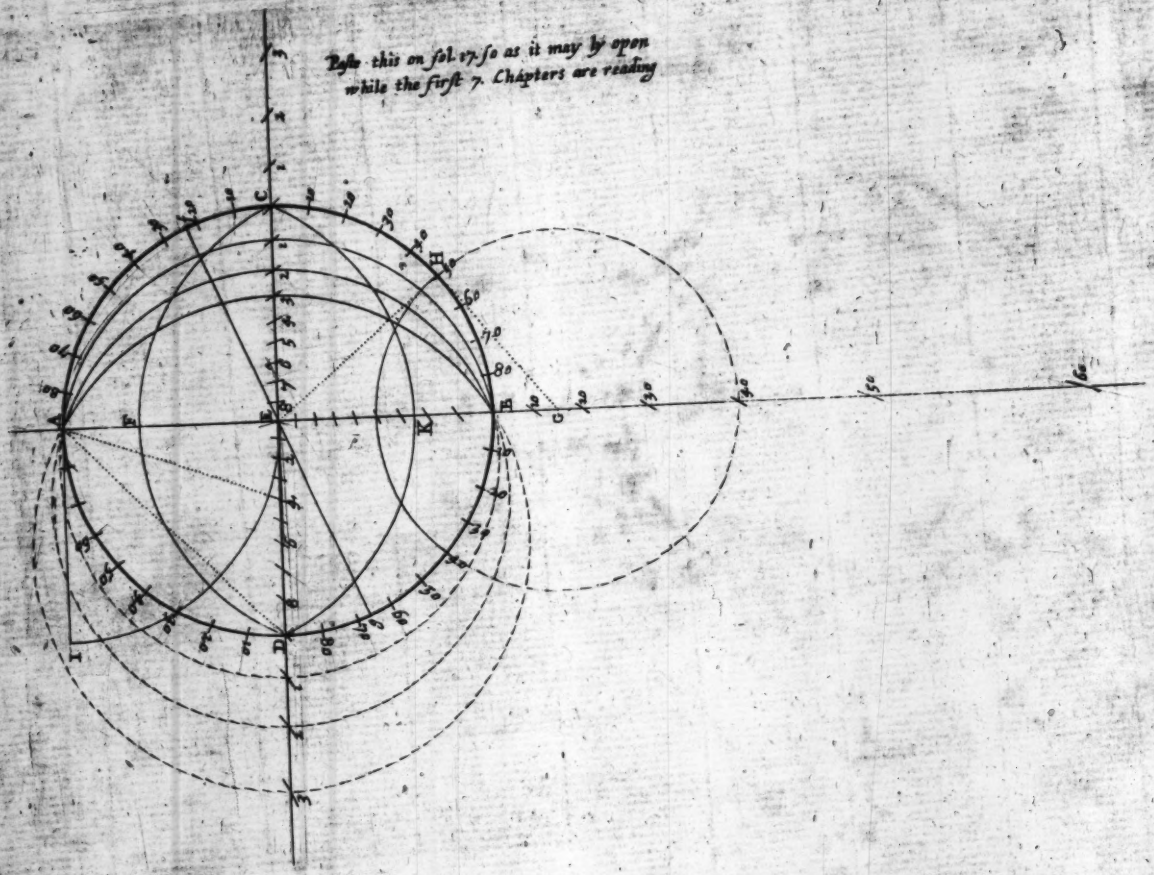
carefull that you cut not into the Center of your *Reet*, but leave breadth sufficient about the Center to hold the Center-pin, which must joyn *Mater Reet* and *Label* together. This remembred, you shall cut out two third parts of the spaces of the Almicanters, beginning from the Horizon C D, and cutting out the breadth of two degrees, after which you shall leave the breadth of one degree; and then cut out again the breadth of two degrees, and so forward. But for the greater strength and ornament of your *Reet*, and for ease in numbring the *Azimuths*, you shall at every 15th *Azimuth* leave a string of the breadth of one degree, whole from the Horizon to the Pole A, or at every thirtieth *Azimuth* leave such a string going quite through, and at every other fifteenth the string may be cut off when it comes within ten degr. of the Pole, because there the spaces of the *Azimuths* be very narrow and close together.

And where among those *Almicanters* and *Azimuths* you have any Star, you must contrive to leave him standing, and to set by him his name or some figure by which you may know him again. But you are to content your self with four Stars on this side the Horizon, because you will want convenient room. On the other side you may have more, and room also to writ their names upon strings or branches left for that purpose; which you may contrive into some voluntary lettes-work, wherein you shall not much regard uniformity of the Quadrants, but to make the *Reet* as open as you can, provided you leave it of sufficient strength.

The cutting of this *Network* requires much labour and care, be sure you use no Punches nor Chesils, nor adventure to stamp your figures, lest you spoile all. But get your Gravers, Drils and Files of several bignesses and fashions, and being to cut out any of the lettesses, lay your plate upon a flat board, or contrive to pintch it between two flat boards, as in a Vice, that it crumple not. The lower board were best have a smal Auger hole, through which your Files may play: the upper board must come close to your work behind, but must not cover it. Then first make way for your Drill with a Graver: next with your Drill (set Perpendicular to the plate) bore two or three holes close together, then get in a smal File, and file them all into one mortes or narrow window, to make way for bigger Files, and when you come near the line be sure your File be not slope but Perpendicular to the plate in working. And to guide your Files Perpendicular in

working

Paste this on fol. 17. so as it may lye open
while the first 7. Chapters are reading



working you may make a long handle to your File, like an arrow shaft, and longer if you will: fasten a board with an hole befitting the handle of your File just over your work; put the shaft or handle of your File through that hole so far that it slip not out in working: and this hole shall so govern your File, that if you set it Perpendicular at first it must needs file Perpendicularly. This device I learnt from an excellent Artificer, M. *Matthew Hill*, of *Bedford*; who by this and such other ingenious devices did cut out two of these *Rects* so exactly and truely, as I think the like hath not been done in metall before.

To cut out the *Reet* in pastbord is much easier, if you be provided of sharp knives and chesills, fitted for your purpose.

A Table of the Right Ascensions and Declinations of 110 *of the more notable fixed Stars; calculated from* Tycho *his Tables: rectified for the year of our* Lord 1671.

	As.	mi.	D.	mi.		
Andromeda *her Head*,	357.	54.	27.	18.	N.	2.
(Mirach) *Girdle.*	12.	49.	33.	55.	N.	2.
Foot (Alamath)	25.	57.	40.	44.	N.	2.
Perseus *his side*, Algenib.	44.	16.	48.	36.	N.	2.
Meadusaes head, Algol.	41.	46.	39.	39.	N.	3.
Henerichus *right shoulder.*	85.	53.	44.	56.	N.	2.
Left shoulder, Alhaiot.	73.	07.	45.	37.	N.	1.
Left elbow.	69.	29.	43.	15.	N.	4.
The Kids.	69.	57.	40.	33.	N.	4.
	70.	51.	40.	42.	N.	4.
	160.	18.	58.	08.	N.	2.
The great Wain.	160.	48.	63.	32.	N.	2.
The Wheels.	173.	59.	55.	33.	N.	2.
	179.	48.	58.	51.	N.	2.
	189.	53.	57.	47.	N.	2.
The Horses.	197.	37.	56.	41.	N.	2.
	203.	37.	51.	00.	N.	2.
The little rain, the Pole Star.	07.	53.	87.	34.	N.	2.
Last Wheel.	231.	14.	73.	15.	N.	3.
Dragons tongue.	254.	36.	54.	55.	N.	4.

	Af.	mi.	D.	mi.		
Head { *first,*	260.	46.	52.	34.	N.	3.
last, Ras Aben.	267.	15	51.	36.	N.	3.
Tail	167.	15.	71.	05.	N	3.
Bootes Arcturus.	210.	13.	20.	58.	N.	1.
Engonasi's Head,	254.	12.	14.	50	N	3
Ophiucus *Head,*	259.	55.	12.	52.	N	3.
Lyra,	276.	27.	38.	30.	N	1.
In Ariadnes *brow,* (Mumir)	230.	12.	27.	51.	N.	2.
The Swans bill,	289.	23.	27.	18.	N.	3.
The Eagles Heart,	293.	41.	08.	03.	N	2.
Tail,	282.	36.	13	25.	N	3.
The Dolphins tail,	304.	24.	10.	14.	N	3.
Pegasus his mouth, (Eniph)	322.	03.	8.	24	N	3.
Head,	328.	24.	4	38.	N.	4.
Neck,	336.	21.	9.	08.	N.	3.
Right shoulder (Sheat,)	341.	59.	26.	18.	N	2.
First in the wing, (Marcab)	342.	07.	13.	28.	N.	2.
Last in the wing,	359.	08.	13.	22.	N.	2.
The Rams head,	27.	12.	21.	54.	N	3.
Horn, ♈	23.	54.	17.	40.	N	4.
	24.	08.	19.	12.	N.	4.
The Bulls North eye,	62.	23.	18.	26.	N.	3.
South eye, (Aldebaran)	64.	17.	15.	48.	N	1.
Brightest of the Pleiades,	52.	00.	23	03.	N	3.
Gemini, *Head of* Apollo,	108.	24	32.	33.	N.	2.
Head of Hercules,	111.	19.	28.	46.	N.	2.
The first foot, ♋	88.	48	22.	33.	N	4.
	90.	48	22.	38.	N.	3.
The third foot,	94.	41	16	38	N.	2.
Cancer, Præcepe,	125.	22.	20.	48	N	ne
Leo, *the Lions neck,*	150.	26.	21.	29.	N.	2.
Heart, (Regulus,	147.	43.	13.	33.	N	1.
Back,	164.	08.	22.	20.	N	2.
Tail,	173.	04	16.	25.	N.	1.
Virgo, Spica ♍, Azimech,	196.	56.	9.	31.	S.	1.
Libra, South ballance,	218.	13.	14.	37.	S.	2.
North ballance,	224.	52.	8	07.	S.	
Scorpio, *in his forehead the lowest,*	234.	50.	25.	06.	S.	3.
Midst,	235.	15	21.	38.	S.	3

Highest

	As.	mi.	D.	mi.	
Highest,	236.	36.	18.	51. S.	3.
Heart, (Antares,)	242.	23.	25.	37. S.	1.
Sagittaries *head, the midst,*	281.	18.	22.	07. S.	4
Capricorns *horn, the highest,*	299.	58.	13.	29. S.	3.
Tayl,	320.	29.	18.	02. S	3.
	322.	15.	17.	32. S	3.
Aquarius right shoulder,	327.	16.	1.	52. S.	3.
left shoulder,	318.	07.	6.	$56\frac{1}{2}$ S	3.
Right leg, (Scheat,)	339.	22.	17.	31. S.	3.
End of the flood (Fomahant,)	339.	46.	31.	17. S.	1.
The Whale, Mandibula,	41.	21.	2.	48. N	2.
Mouth, the midst,	36.	36.	1.	50. N	3.
Cheek,	35.	44.	1.	07. S.	3.
Belly, (Baten Kaitos)	23.	52.	11.	54. S	3.
Tayl, { *Northern,*	0.	43.	10.	37. S.	3.
Southern	6.	45.	19.	48. S	2.
Orion. *Right shoulder,* Bedalgieure	84.	23.	07.	18. N	1.
Left shoulder Bellatrix,	76.	54.	06.	01. N	2.
Girdle the first,	78.	52.	0.	35. S.	2.
Second,	79.	55.	1.	26. S.	2.
Third,	81.	04.	2.	09. S.	2.
Left foot, (Rigel)	74.	44	8.	37. S.	1.
Right foot,	83.	03.	9.	49. S.	3.
The great Dogs mouth, Alhabor, *Sirius,*	97.	42.	16.	$14\frac{1}{2}$ S.	1.
Formost foot,	92.	08.	17.	49. S	2.
The litle dogs neck,	107.	22.	8.	54. N	3.
Thigh, Procyon,	110.	34.	6.	03. N	2.
Hydra, *the heart,* (Alphard)	137.	54.	7.	15 S.	2.
Corvus, *in his beak, the first of the* □,	177.	50.	22.	54 S.	4.
Second of the □,	179.	49	15.	39. S.	3.
Third of the □,	183.	16.	14.	39. S.	3.
Fourth □,	184.	20.	21.	33. S.	3.

Chap. VIII.

Of the Ring, *or* Limb *of the* Mater.

THe third part of this Inſtrument is the *Ring* or *Limb*, which is nothing elſe but the skirt of a Circular plate equal with the *Mater*, whoſe middle is cut out by a leſſer concentrique Circle. It is bounded with two Parallel Circles, the outmoſt muſt touch the edge of the *Mater* round the inner Circle or edge of this Ring: it muſt be a little leſs then the *Limb* of the *Reet*, that it may take hold of the *Reet* to keep it flat and ſafe from harms. This Ring had need be thicker then the *Reet*, but not ſo thick as the *Mater*; and for breadth, about $\frac{1}{10}$ part of the Diameter. It muſt be pinned or ſcrewed on to the *Mater* with 6 or 8 pinnes or ſcrews, that ſo you may take your plates aſunder when need is to cleanſe them from any ſtain or duſt that may get between. Let the pins that carry the naile-ſcrews be rivetted in the *Ring*, and th ir heads ſo filed down and poliſhed that they be not ſeen to check the *Label*: and holes being made in the *Mater* for the pins to paſs through, you ſhall have ſmal ſcrews of what faſhion you like beſt, to turn upon them on the backſide; theſe ſcrews would be made all of a length, and may ſerve as feet to bare up the Inſtrument about a third part of an inch from the ground, that it be not ſcratched and be readier to take up.

And that the *Reet* may turn more pleaſantly under the *Ring*, and lie as near as may be in the ſame plain with the *Ring*, you ſhall abate half the thickneſs of the upper edge of the *Reet*, about a barly-corn's breadth round about, ſo far as he ſhall run under the *Ring*: and likewiſe aba e half the thickneſs of the inner edge of the *Ring* on the lower ſide where he claſps down the *Reet*, (which a good Turner knowes now to do;) or you may make a ſhift to do it with a beam-compaſs, if you make your running point like a narrow cheſill.

Your *Ring* thus fitted to the *Mater*, you ſhall ſet one foot of your Compaſſes in the Center of the *Mater*, and with the other draw near the inner edge of the *Limb* a Circle about $\frac{9}{100}$ of an inch diſtant from the edge. Alſo opening your Compaſſes about $\frac{3}{5}$ of an inch more you ſhall draw another Parallel Circle: and laying

laying your Ruler or *Label* from the Center to the several degrees of the fundamental Circle of the *Mater*, you shall draw short lines for every degree from the inner edge of the *Ring* to the first Circle, and every tenth degree you shall prolong to the second Circle, and let every fifth be drawn half way. Between these two Circles also you shall set figures to every tenth degree; numbring from the Equinoctial line C D to the Poles on both sides both wayes. Also without the second Circle you shall set great figures for the several Hours, setting XII at C, and thence proceeding in order to the right hand toward B, at 15 degrees set I. at 30 degr. set II, at 45 degr. set III, and so on, till you come to D, where you must set XII. Thence you shall proceed in the other Semicircle D A C, setting I, II. III, and so on in order, till you be come round: And remember that you write on the *Ring*, at A *Oriens*, at C *Meridies*: at B *Occidens*, and at D *Septentrio*,

Chap. IX.

Of the Ephemeris *or* Calender, *on the* Ring.

IF there be space enough left upon the *Ring* without the Circles of the degrees and Hours, you may fill it up with the *Ephemeris* of the Sun in this manner:

The former Scale on the inner edge of the *Ring* shall serve you to this purpose for an *Ecliptique*; and you may set to him the Characters of the Signes, if you will, at every thirtieth degree; beginning at *Oriens* and there setting ♈, and ♎ at *Meridies*, and the rest in like order.

Then draw another Scale without this, upon the *Ring*, consisting of two spaces In the inner space shall be the Dayes of the Year: in the outer space (which must be a little larger) shall be the Names of the moneths in their order,

And to divide this Scale rightly you shall do thus. Go to some *Ephemeris* for the Leap Year that next comes, *viz.* 1660, (or rather for some Leap Year about 20 Years hence, that your Scale may serve without any *Prosth. pheresis*, for 40 Years to come without sensible error, and beginning your year with *March*, look where the Sun was on the 29 of *February* at Noon; which you shall find to be ♓ 20 degr. 47 min. for the Year 1660. Therefore laying the *Label* or a Ruler from the center to ♓ 20 degr. 47 min.

47 min. in the inner Scale, strike a long stroke through your outward Scale, and from thence begin your Year, writing from thence toward the right hand ☌ *March* 1660. Then lay the *Label* to ♓ 21 degr. 47 min. (which is the Suns place on the first day of *March* at noon the same year) and where it cuts the outer Scale, mark the first day of *March*, and so the rest in order. And to the first day of every moneth, you shall set his proper Letter which belongs to him in the *Calender*; as to the first of *March* you shall set D, and to the first of *April* G, &c. and when you have done *December*, you must take the Suns place for *January* and *February* out of the next years *Ephemeris*, *viz.* 1661, and note that the space for the last day of the year (*Febr.* 28) will fall out to be less by a fourth part then the rest, by reason that the Sun wants almost 6 hours to finish his Circle, which he finishes in dayes 365, 5 hours 48 minutes. And for this cause these Scales will serve you to find the Suns place at noon, for any day in a like year, that is every fourth year, accounted hence, either backwards or forwards; which year shall evermore be accounted to begin from *Febr.* 29. and may be accounted the first year after Leap year, because the Intercalation was *February* 25 next before. Then for the year next following, *viz.* 1661. (beginning *March* 1 and being second from the *Bissextile* or Leap year) these Scales shall give you the place of the Sun at six hours after noon, and the third year from *Bissextile* 1662 (beginning as before *March* 1) these Scales shall give you the Suns place 12 hours after noon, or the midnight following. And the fourth year 1663 being *Bissextile*, these Scales shew the place of the Sun at 18 hours after noon, the next year 1664, being the first after *Bissextile*, and beginning (as aforesaid) ☌ *March* 1, is the very same year for which your Scale is made and gon, for that year: your Scale shewes the Suns place at noon again.

But because the *Julian* years are bigger then the true Solar years by almost 12 mi. of time (that is, near a quarter of an hour) in which time the Sun moves 27 sec. 13 thirds 37 fourths, therefore when you have found the Suns place by the former Scale, any year after 1660, look how many years are passed since 1660 and so many times you must add 27 sec. 13 thirds 37 fourths, (that is almost half a minute) to the Suns place found: and for years past you must subtract as much, that you may find the Suns place exactly. This *Prosthapheresis* in 2 or 3 years is scarce considerable

in

in an Instrument, but in 10 years there will be 4. minutes 32. seconds, and in 20 years 9. minutes 5. seconds, to be added after 1660. and as much to be subtracted in like number of years preceding the year 1660. to which this Scale is supposed to be framed.

This *Ephemeris* or *Calender* M. *Blagrave* would have on the back-side, where hee would also have a Ruler with Sights, to take the Altitude of the Sun or Stars. But this will be found incommodious in many respects, both in the framing, and in the using; and therefore I advise that nothing be set on the back-side but the Tables of the *Prime*, *Epact*, and *Cycle of the Sun*, thereby to find the age of the Moon, her Conjunctions and Oppositions, and the moveable Feasts for ever, Of which see Chap. 11.

Chap. X.

Of the Label *and* Sights.

The *Label* is a Ruler slit in the midest, and the half of it cut away to the Head, where it is pinned to turn upon the Center, and reaching to the outside of the Limb. The Fiducial edge thereof, which pointeth upon the Center, must be graduated, like to the semidiameters of the *Mater* and *Feet*, into 90 degrees, to be numbred either inward or outward. The fashion of it may be understood by the figure without more words.

To this *Label* you may fit Sights, either fixed or moveable, as you like best, for observing *Altitudes* and *Azimuths*: but for taking *Azimuths* you had need have one tall Sight, at least half as long as the *Label*: and then it had need be moveable, to take off at pleasure.

For taking the *Altitude* of the Sun, I have made a pair of moveable Sights, to slip up and down upon the edge of the *Planisphear*; having on the backside springing plates of brass to pinch them close, and make them stick where you set them. These are commonly to be set at C and D the ends of the Equinoctial line. At A in the *Limb* and in the Circle next unto the inner edge which boundeth the strokes of the severall degrees, you shall drill a small hole, through which you may put a thred

a thred to hang a plummet on. The Sun then shining through the Sights placed at C and D, the plumb-line shall shew his Altitude in the semicircle B C A, you beginning to number from B, and observing where the plumb-line crosseth the Circle in which the hole for hanging the plumb-line was made. And here you must remember that because the plumb-line falleth not from the Center of the *Planisphear*, but from a point in the circumference about A, therefore the space of two degrees must be taken but one degree, so that if the Plumb-line fall 20 degr. below B toward C, the Suns *Altitude* is 10, degrees as you may see demonstrated, *Euclid.* 3. 20. and *Pitisc. Trigonem.* 1. 53. And thus you may observe the Suns *Altitude* neer the Horizon, as exactly as by a *Quadrant*, whose semediameter were equal to the diameter of your *Planisphear*. But if the *Altitude* exceed 30 or 40. degrees then will the Plumb-line cut the limb too slope and have too much play to your trouble: For remedy whereof you shall remove the Sight at D towards A some degrees: as for example 60 degrees, by which means you shall abate the Suns *Altitude* 30 degrees, which 30 degrees must be added to the *Altitude* observed: as for example, the Sights are placed one at C, the other 60 degrees above D toward A, and the Plumb-line cuts 10 degrees from B towards C, I say, then is the Sun 5 degrees high and 30 degrees more, in all 35 degrees: in like manner you may place the Sight at any other number of degrees from D toward A, as you shall find most convenient for the present *Altitude*; remembring always that how many degrees soever you remove the Sight, half so many are to be added to the *Altitude* found. But if your *Reet* happen to run so far under the *Limb*, that you cannot make a center-hole for the Plumbet through the *Limb* and *Mater*, without hindring the *Reets* motion, then may you have a small plate of sheet brass, in fashion of an Arm or Tongue, in the point whereof you shall have a Center-hole drilled, and this plate shall be so joyned with a sluce or screw about the *Limb* near A, that the Center-hole made in this plate may lie close to the point where the Center should have been boared in the *Limb* in the line A B: and thus you may put it on, and take it off, at pleasure, that it hinder not the motion of the *Reet* or *Label*. Of the fashion of the Sights see more Booke 4. 2.

CHAP.

Chap. XI.

Of the perpetual Calender, *on the back-side.*

ON the back-side of your *Planisphear* you may set the *Calender* following, which consisteth of three Tables gathered round. The longest would be set outtermost. The first is the Table of the *Cycle of the Sun*, that is of the *Sundays Letter*. This is here placed in the middle. It is a Cycle of 28. years, in which time the *Dominical Letter* runs all his changes, (caused by the one odd day above 52 weeks) in every Common year, and two odd days which run over the even weeks in the *Leap years*. To find the beginning of this Cycle, add to the year of our *Lord* 9. (because the first year of our *Lord*, as wee commonly acount, was the 10 of this Cycle) and divide the sum by 28. the remainder is the year of the Cycle running; and if nothing remain, then it is the 28. or last year. So you shall find that the Cycle now running shall end with the *Julian* year 1671. as in the Table; and shall begin again with the year of our *Lord* 1672. Thus may you renew the Table when it is expired; or make this very Table serve you for ever.

Example.

Enter this Table with the year of our *Lord* 1656. now running; and you shall find over against this year in the next space inwards 13. shewing you that it is the 13 year of the Suns Cycle; (so shall the 28 year forward *viz.* 1684 be again the 13th year of the Cycle next comming.)

In the next space within, you have the *Dominical Letters* F and E, (because it is *Leap year*) F shall be the *Dominical Letter* till you come past the *Intercalary* day, which is the day following the 24th of *February*: and for the rest of this year the *Dominical Letter* shall be E; (for the Letters always change backwards) also you shall note here that the day inserted in every 4th year is not *February* 29, but *February* 25. for *February* 24, (being 6 *Cal. Martij*) is repeated again in the *Leap year*: and they write again *February* 25. 6 *Cal. Martij*: and the 25th of *February* in the *Leap year* is marked with the same letter F,

wherewith the 24th of *February* hapneth always to be marked. Hence the *Leap year* is called *Annus Bissextilis*: and note that by the *Ecclesiasticall* Law S. *Matthias day*, which is *February* 24th in common years, in the *Bissextile* years is to be observed on *February* 25. Nevertheless in our Secular Law not the 24th and 25th of *February*, but the 28th and 29th in the Leap year are ordained to be one day in the account of Law: as by *Statutum de Anno Bissextili*, made in 21 year *Henry* 3. may appear.

The second Table is of the *Cycle of the Moon*, consisting of the *Prime* or *Golden Number*, and the *Epact*. This Table contains 19 years, which is the *Annus Metonicus*: in which space of time *Meton* an Astronomer about 430 years before *Christ*, observed the Moon to finish all her variations. So that every 19 year the mean conjunctions or changes should happen upon the same days of the moneth, that they did happen upon 19 years before; onely an hour and half sooner. Yet beeause every 19 years contain not the same number of *Leap years*, but sometime there come five *Leap years* in 19 years, and sometimes but four, therefore there may happen in this Period of *Meton* an error of an whole day, besides the hour and half above mentioned. For remedy whereof *Calippus*, about the 330 year before *Christ*, devised to quadruple this period of *Meton*, making *Periodus Calippica* of 76 years, which contains just 19 quaternions of years; so containing always the same number of *Leap years* and days. This period is therefore more perfect then *Metons*: for after this period of 76 years, the Moon runneth over the same course for her conjunctions and oppositions; changing in the same year of the period always, upon the same day of the moneth, save onely that shee changeth sooner by six hours in the latter period then in the former.

But the Church still retaineth the period of *Meton*, called the *Prime*, or *Golden number*; because it used to be set in Golden letters in the *Kalender*, in a certain artificiall order throughout every moneth, to guide you to the day of the Moons *Priming* or *Changing*: so may you find it in red letters, thus, Set to the *Kalender* printed in large folio with the *Book of common Prayer*, in the time of the late Queen *Elizabeth*. To find the year of the *Prime*, add to the year of our Lord 1, and divide the sum by 19. the remainder is the year of the *Prime*, or if nothing remain it is the 19th or last year. Thus you may find the present

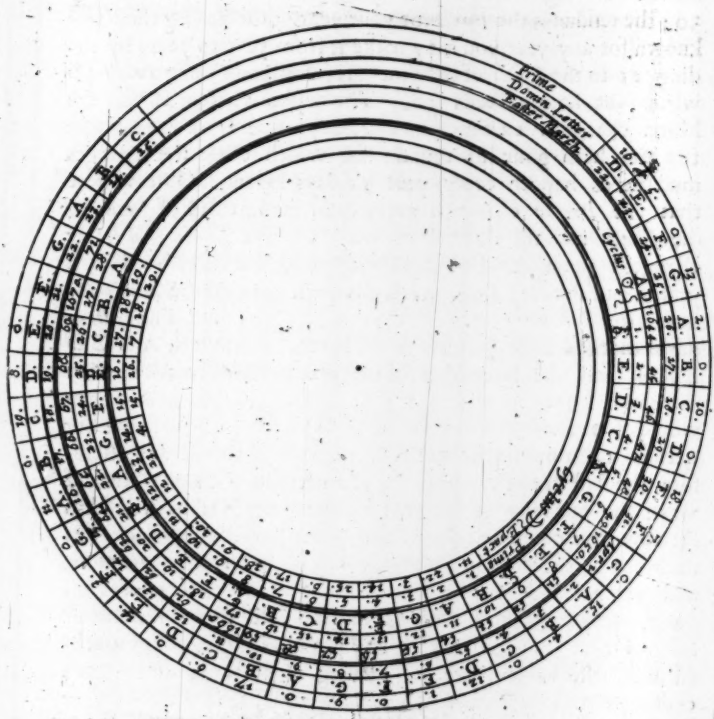
year

year 1656, to be the fourth year of the *Prime*, and so you find it in the Table. The *Cycle* or *Period* now running, ends with 1671. and begins again with the year following.

The *Epact* or *Concurrent* is set against the *Prime* in the next space inwards: and finisheth his Cycle in the same time. It was devised to find more readily the day of the change, and age of the Moon. The way to find it is this. Multiply the *Golden number* serving for your year by 11, and divide the product by 30; the residue is the *Epact* for your year. Or having the *Epact* known for any year, you may make it from year to year, by adding 11 to the *Epact* of the year foregoing, and casting away 30 when the sum exceeds 30. The reason whereof is, that the Moon changeth 12 times in 354. days, that is 11 days before the Sun hath gone his round: for which cause the changes must needs happen every year 11 days sooner. Observe here that the *Prime* changeth every year the first day of *January*; the *Epact* not till the first of *March*. The *Dominical letter* changeth upon the first of *January* going one letter backward yearly; and in every *Leap year* it changeth again on the *Lords day* next after *February* 24. The reason whereof is this: The *Calender* is marked throughout with the letters of the week A B C D E F G, and the same day of the year is always marked with the same letter, now if the year contained even weeks then would the *Dominical letter* be always one and the same: but because a common year contains 52 weeks and one day, therefore the last day of the year must be marked with A, as the first was; the first day of the year following again is marked with A: now put case the last of *December* marked A, be *Sunday* in the year 1654. the day following *viz. January* 1, is *Munday*, and yet marked A; and the first *Sunday* in 1655 must needs fall on *January* 7 marked with G: and so G became *Dominical letter* for 1655. as A was for 1654. and as those 2 days marked with the same letter A, coming together at every years end cause a change of the *Dominical letter*, so in the *Leap year* the Intercalary day *February the* 25, being marked with F, always as the 24th is, the coming together of those two dayes marked with one letter, causeth a second change of the *Dominical letter* for that year by like reason.

The third Table is a Table to find *Easter* for ever. This is placed outmost because it is the longest. It was very fally

ordered in M. *Blagraves book*: and so it is in *Grostons Tables*, from whence I suppose he transcribed it. I have set it right and straight, and taken what care I could that the *Printer* or *Graver* do not put the ranks into the same disorder in which I found them, both in *Blagrave*, and in *Grostons Tables*, printed 8 years before him.



Chap. XII.

Some cautions to be Obſerved in the making of the Inſtrument.

THough I have taught the making of the *Mater* firſt as being the baſe and principal part of the *Inſtrument*; yet I ſhall adviſe you firſt to draw and cut out the *Reet*, and fit the *Label* to it, leaving it ſufficient length to reach to the out-ſide of the *Mater*. And then having your *King* ready fitted to ſcrew on to the *Mater* you ſhall drill the centers of the *Mater*, *Reet*, and *Label*, with the ſame drill; and faſten them together with a *Center-pin* well fitted to the bore: this *Center-pin* muſt not be too big: let it be ſquare at the head to ſtick in the backſide of the *Mater*, that it turn not; and let the other end have a male ſcrew, upon which you ſhall turn a female ſcrew, to draw the plates together; ſo that they be neither too looſe nor ſtick too hard. Then take a great needle, or ſuch a round point of hardned ſteel, and bearing it up into ſome corner of the *Reet* cloſe to the inſide of his *Limb*, turn about both *Reet* and Needle upon the *Mater*, ſo that the Needle may trace out the great Meridian of the *Mater*, and ſo the principall Circles of the *Mater* and *Reet* ſhall be ſure to be Conceatrique, and to argree in all poſtures of the *Reet:* whereas if you draw the Meridian of the *Mater* before you have bored the Center, and fitted on the *Reet*, you ſhall hardly happen to bore ſo true, but you ſhall find the Circles to be a little Eccentrique and interfering one with another. And to avoid the like Eccentricity in the Circles of the *King*, it were beſt to have a ſorry Beam Compaſs made onely for this purpoſe, and fitted to your Center pin to draw them by: yet if thoſe be drawn from the Center of the *Mater* unbored, there will be no perceiveable error, if you devide them from the *Limb* of the *Reet* by the *Label* when all is pinned together. Theſe things done, quarter the Meridian of the *Mater* with two croſs Diameters, and divide them as is above directed; remembring to apply your *Reet* to the *Mater* often, to ſee how the diviſions of the Diameter agree, and how the Meridians and Parallels which you are drawing on the *Mater* agree with the *Azimuths* and *Almicanters* of the *Reet*. And thus by comparing your plates often, and examining the lineaments of the one by the other, as you draw them, you ſhall avoid many ſlips and miſtakes, and proceed in your work with more confidence and contentment.

The end of the firſt Book.

The ſecond Book.

Of the ſeveral Projections of the

SPHEAR;

which are repreſented by this

PLANISPHEAR.

The Preface.

THe Sphear *may be Projected fitly upon the* Plain *of any great Circle: but the Projection will be of little uſe for reſolving Queſtions in* Aſtronomie, *unleſs it be made upon one of theſe foure, the* Meridian, *the* Equator, *the* Azimuth *of the* Nonageſimus gradus, *or the* Horizon. *This* Planiſphear *is fitted therefore to repreſent all thoſe four Projections, and eſpecially the two former.*

CHAP. I.

Of the Planiſphear *in the Meridional Projection, repreſenting the Eaſtern or Weſtern* Hemiſphears: *And of his three Modes or poſtures.*

WHat M. *Blagrave* Book 2. Chap. 15. 16. calleth the firſt and ſecond diſtinction of the *Jewel*, I call the firſt and ſecond Meridional and Equinoctial Projection of the *Planiſphear*, for which change of termes I hope the Judicious Reader will not blame me. The Meridional Projection is the Eaſtern or Weſtern *Hemiſphear* projected

projected upon the plain of the Meridian of your place, which is the great and cheif Meridian in every Country, passing through the *Zenith* and *Nadir* of the place, as well as through the Poles of the World. The eye in this Projection is supposed to be placed in the East or West point of the Horizon. The lineaments which belong to this Projection are the innermost Scale of the *Ring*, and all the lineaments of the *Mater* and *Reet*, except only the *Zodiack* of the *Reet*, and the Stars. Here the outmost Circle both of the *Mater* and *Reet* represents the great Meridian of your place, and the Scale upon the inside of the *Ring* divided into 360 degrees serveth to divide the said Meridian: for the *Label* laid upon any degree of the Scale of the *Ring* cutteth the same degree in the Meridian Circle; because it is concentrick thereto.

This Meridian also standeth for *Colurus Solstitiorum*, (so they call that Meridian which passeth through the beginning of *Cancer* and *Capricorn*) for though all the Meridians in 24. hours space do successively come into the Meridian of your place (which is the Noon Circle passing over your head North and South) and the *Sphear* may be divided into Eastern and Western *Hemisphear* by any of these Meridians, when they become Vertical, yet the *Sphear* is then in the best posture to be divided for our purpose into East and West, when *Cancer* is Southing, *Capricorn* at midnight, and ♎ 0 rising full East, and ♈ 0 setting full West.

In this Meridian at A, or *Oriens* is the North Pole, and the South Pole at B, or *Occidens:* for the words *Oriens and Occidens* are there placed to serve the Equinoctial Projection. The Concurrent Circles meeting in the Poles A and B are Meridians. Those Meridians are 180 in number, and divide the Equator C D into 360. degrees, because every one of them cutteth it twice, that is once in each *Hemisphear*. By these are numbred the Right Ascensions of the Stars and Planets, and the hours and minutes of Day and Night: for every 15 of these Meridians numbred from the *Limb* is an hour Circle, as hath been shewed (Book 1.6.) they are numbred from D to C, that is, from *Septentrio* to *Meridies* 1.2.3. &c. for the Morning hours, and back again from C to D, in like manner for the Afternoon: the Axeltree line A B falling out to be the six a clock line both ways. By those Meridians also are numbred the Longitudes of Towns and Countries in *Geography*.

The Circles or Semicircles crossing these Meridians are the Parallels

Parallels of Declination: they are leſſer Circles whoſe propertie it is to divide the *Sphear* into unequal parts. In the midſt of them lies the Equator C D, being here a ſtraight line, and cutting the Axtree-line A B at Right Angles in the Center E: the Parallels are greateſt near the Equator, and from thence they leſſen toward the Poles, they are 180 in number *i.e.* 90 on each ſide the Equator, ſave that the two extream Parallels are reduced to two points in the Poles. By theſe Parallels are numbred the Declinations of the Stars in *Aſtronomie*, and the Latitudes of Towns and Countries in *Geography*.

And this name and uſe have the Circles of the *Mater* always in the Meridional Projection. The *Ecliptick* always ſtandeth for it ſelf, when it is uſed, which is onely in the firſt Mode of this Projection. But the Circles of the *Reet* have divers names and uſes, in the divers Modes of this Projection, which here follow.

1 *The firſt mode of the Meridional Projection.*

The point A of the *Reet* in which the Concurrent Arches meet, is called the *Vertex* of the *Reet*. Set the *Vertex* of the *Reet* to the Latitude of your place, ſo ſhall the *Vertex* be *Zenith*, and the Concurrent Arches there meeting ſhall be *Azimuths*, called alſo *Vertical Circles*, and *Circles of Poſition*, paſſing from *Zenith* to *Nadir*, and dividing the Horizon into 360 degr. as the Meridians on the *Mater* paſs from Pole to Pole; and divide the Equinoctial. The Semicircles croſſing theſe *Azimuths* ſhall be *Almicanters* or Circles of Altitude. The Diameter croſſing the Axeltree of the *Reet* at Right Angles ſhall be the *Horizon* or *Finiter*, whoſe Graduations are ſet to him in a border below the Center, and from him are the *Almicanters* reckoned upward to the *Zenith*. The *Azimuths* may be reckoned from the North or South Semicircles of the Meridian, or from the Axtree line of the *Reet*, which is the Eaſt or Weſt *Azimuth*, commonly called the *Prime Vertical*. When I bid you ſet the Vertex of the *Reet* to the Latitude of your place; you muſt firſt know what your Latitude is. It is the neareſt diſtance of your place from the Terreſtrial Equinoctial, numbred in degrees and minutes of a great Circle. The Latitude of *London* is 51 degr. 32 min. North. The Latitude of *Eſton* or *Northampton*, is 52 degr. 15 minutes, or very near, And how to get the Latitude of theſe

or

or any other place ſhall be ſhewed Book 4. 11. The Latitude had, number the degrees thereof upon the *Ring* from C or *Meridies* (where the Equator cutteth the Meridian) toward A or *Oriens*, which in this Projection is the North Pole, becauſe we in England have North Latitude. At the end of this number ſee for *London* 51. degrees 32. minutes, from the Equator Northward, ſet the Vertex of the *Reet*, ſo this Vertex repreſenteth the Zenith, or point in the Heaven which is juſt over your head, in which point all the Azimuths meet, and through which alſo paſſeth the Meridian of your place, which here is repreſented by the outmoſt Circle of the *Mater*, or the innermoſt Circle of the *Ring*. Now is the upper Semicircle of your Meridian divided into four notable parts. From the Zenith Southward to the Equator is the Latitude 51. degrees 32 minutes, from thence to the Horizon is the complement of the Latitude 38. degrees 28. minutes, making up a Quadrant: againe from the Zenith Northerly to the Pole, is the complement of Latitude 38. degr. 28. minutes, as before: and from thence to the North of the Horizon is the Elevation of the Pole above your Horizon: which is always equall to the Latitude of your place: for where in a right *Sphear* the Poles ly in the Horizon, and have no Elevation, there the Equator paſſeth through the Zenith, and if you go from ſuch a Country Northward till the Pole be Elevated one degree, the Equator ſhall there decline from your Zenith one degree Southward, becauſe the Equator keeps always the diſtance of 90 degrees from the Poles. And this diſtance of the Zenith of your place from the Equator is called by Geographers *Latitude*, and is always equal to the Elevation of your Pole. So that it is all one whether you ſet the Vertex 51. degrees 32. min. above the Equator, or ſet the North point of the Horizon 51. degrees 32. minutes below the North Pole.

Now the Vertex of the *Reet* ſet to the Latitude, and conſequently the Pole mounted to his due Elevation, your *Planiſphear* is in a right mode and poſture ſpeedily to reſolve all queſtions concerning the Diurnall motion; as the Suns longitude, Declination, Right Aſcenſion, the Aſcenſionall differences, with the Semidiurnall Arch or length of the day, the Suns Altitude, Azimuth, and Amplitude; the hour and minute of the day, the beginnings endings and duration of twilight, and ſuch like; and that with ſo great facility, that having onely the Longitude of

the Sun (with the Ephemeris on the *Ring* ſhall give you for asking) and therewith either the Altitude Azimuth or Houre, one of them: you may ſee all the reſt at the firſt view without changing the poſture of your Inſtrument; as ſhall appear in the fourth book.

2 *The ſecond Mode of the Meridional Projection.*

Set the Zenith, or Vertex of the *Reet* to the North Pole of the Ecliptick, (or which is all one) ſet the Horizon line of the *Reet* in the Ecliptick line of the *Mater*, ſo the Azimuth ſhall in this poſture become Circles of Longitude, and the Almicanters Circles of Latitude: And in this Mode your *Planiſphear* is fitted to reſolve all Queſtions of the Longitude, Latitude, Right Aſcenſion, and Declination, of the Stars.

3 *The third Mode of the Meridional Projection.*

Number the *Altitude* of *Culmen Cæli*, (that is the Southing point of the *Ecliptick*) in the *Ring*, from the North Pole toward *Meridies*, if the Aſcendant be a North Signe, or toward *Septentrio*, if the Aſcendant be a South Signe. To the end of this numeration palce the Finiter. Reckon alſo upon the Finiter from the Center toward *Septentrio* the *Amplitude* of the Aſcendant; the Meridian cutting there gives you the arch of the *Ecliptick* from the Aſcendant to the Midheaven: and his match taken ſo many degrees on the other ſide the Center gives the other arch of the *Ecliptick* from the Midheaven to the Deſcendant. The reſt of the Meridians and the Parallels are in this Mode of no uſe. The *Almicanters* and *Azimuth* of the *Reet* here ſhew you the *Altitude* and *Azimuth* of every degree of the *Ecliptick* at one view.

CHAP: II:

Of the Equinoctial Projection: ſhewing the Northern or Southern Hemiſphears.

THe Equinoctial Projection repreſenteth the Northern or Southern Hemiſphear projected upon the plain of the Equator. Here the *Limb* or outmoſt Circles of the *Mater* and *Reet* are Equator. The eye-point

is

is the North or South Pole, which you will, by turns. Which Poles are here expreſſed on the Center of the Equator, becauſe the Sphear is pictured on a plain or flat. The Axtree line of the *Mater* A B is *Colurus Equinoctiorum*, the Diameter C D croſſing him is *Colurus Solſtitiorum*. But contrary on the *Reet* the Axletree is *Colurus Solſtitiorum* and the Finiter *Colurus Equinoctiorum*. The *Colurus Solſtitiorum* on the *Mater* is alſo the Meridian of your place, and therefore is marked with *Septentrio*, and *Meridies*; and the ends of the Axtree with *Oriens*, and *Occidens*. The reſt of the Meridians being all ſtraight lines meeting in the Poles or Center, are eaſily ſupplyed by the *Label*: and ſo may the Parallels alſo, being Concentrick with the Equator. For if you lay the *Label* on the 15. degree in the *Limb* from *Meridies* toward *Occidens*, the fiduciall edge of the *Label* there deſigneth the 15 Meridian, or the One a clock line: the North Quadrant of the ſaid Meridian proceeding from the Center (now the North Pole) outward to the *Limb* or Equinoctial, and the South Quadrant returning in the ſame line from the Equinoctial to the *Center*: (now the South Pole:) and if you remove the *Label* 180. degrees from One a clock of the day, there it ſhall deſigne One a clock at night, made by the other Semicircle of the ſame Meridian, which joyneth with his match in the Center without any angle, that is, into the ſame ſtraight line: and ſo of the reſt.

And for the Parallels, if you ſet the point of your Compaſs or a needles point in the 23. degree $\frac{1}{2}$ of the *Label*, and turn about the *Label* with the point, it ſhall deſcribe a Circle which will ſerve for both the Tropicks: and ſo may you make any other of the parallels. I do not adviſe you to draw the Meridians and Parallels in this form, leaſt you cumber your Inſtrument, but I ſhew you how you may repreſent any of them in a moment, when ocaſion requireth.

The Meridians of the *Mater*, (that were ſo called in the Meridional Projection) are here turned into the ſeverall Horizons of the World. And the Parallels here ſerve only to graduate thoſe Horizons. Out of theſe Horizons chooſe your own Horizon, and diſtinguiſh him if you will that you may readily find him when you ſhall looke for him.

Your Horizon is thus inquired. Becauſe the Elevation of the Pole at *Northampton* is 52. degrees 15. minutes, therefore

from the Center (now North Pole) number in the Meridian line Northward 52. degrees 15. minutes, and there cutteth the the North Semicircle of our Horizon, or there you may Imagine him between the 52 and 53 Horizons, and the Southern Semicircle thereof lies 52 degrees 15 minutes on the other side the Center towards *Meridies*. This may seeme strange that the North and South points of the Horizon, which in the *Sphear* are unequally distant from the North Pole, *viz.* the one but 51. degrees 15. minutes, and the other 127. degrees 45. minutes, (the supplement thereof) should be equally distant in this Projection. But the reason is because the Center is both North and South Pole here at pleasure, and the Northern and Southern *Hemispheares* are both here represented by turns. Carry this in your head, and then lay the *Label* upon the South part of the Meridian, and number thereon from the Center (now North Pole) outward to the Equator at the *Limb* 90. degrees, thence number backward toward the Center (now the South Pole) the Elevation of the Equator (which is always complement of the Elevation of the Pole, and is here 37. degrees 45. minutes) there is the Southern point of the Horizon, and is distant from the Center (now South Pole) onely 52 degrees 15 minutes, but from the Center being North Pole 127. degrees 45. minutes, and from the Northern point of the Horizon before found just 180. degrees, as it is in the *Sphear*. Having found the North arch of your Horizon 52. degr. 15. min. behind the Center; count as many degrees and minutes forward in the Meridian before the Center toward *Meridies*, and the arch crossing there shall be his match to make up the whole Circle; and so may you find your whole Horizon upon the *Mater* whatsoever your Latitude be.

Here you must remember, that Stars which have Northern Declination rise and set upon the Northern arch of the Horizon; and those which have Southern declination upon the Southern arch. Remember also, that many Stars between the Tropicks which have Northern Latitude, have nevertheless Southern Declination, and contrary many which have Southern Latitude have Northern Declination.

The lineaments of the *Reet* serving you in this Projection, are onely the Ecliptick, and the fixed Stars, the Almicanters and Azimuths here are of no use. The Meridians and Parallels

are

are ſupplyed by the *Label*, for the *Reet* as well as for the *Mater*.

And whereas the Ecliptick here ſeemes to be irregular, ſeeing the *Solſtitial* points of *Cancer* and *Caprcorn* are not diſtant 180 degrees, as they ſhould be, you muſt imagine that the Southern arch of the Ecliptick is Projected by the eye placed in the North Pole, and for the Northern arch the eyes place in the South Pole: and the Center ſerveth for both the Poles alike, as hath been ſhewed: number therefore as you were taught for the Horizon in this Projection. For the reaſon of the draught of the Horizon and of the Ecliptick in this Projection is the ſame.

Chap. III.

Of the Nonageſimal *Projection, ſhewing the Eaſtern and Weſtern parts of the* Sphear, *being divided by the Azimuth of the* Nonageſimus gradus.

Number in the *Limb* from the Equinoctial line toward the Pole the Altitude of the *Nonageſimus gradus*, (which is the higheſt degree of the Ecliptick) and thereto ſet the Finitor, turning the Almicanters either to the North or to the South, as your work propoſed ſhall require.

Now is the Finiter Ecliptick, his point at the *Limb* is *Nonageſimus gradus*. The Center of the *Planiſphear* is Aſcendant and Deſcendant, the Eaſt and weſt points of the Horizon are here diſtant from the Center as much as the Amplitude of the Aſcendant cometh to, to be counted from the Center upon the Eqinoctial line of the *Mater*, which here ſtands for Horizon: the Meridians and Parallels of the *Mater* are here Azimuths and Almicanters, but the Azimuths muſt be numbred from the Eaſt point of the Horizon. The Azimuths and Almicantars of the *Reet*, are here Circles of Longitude and Parallels of Latitude. Here are no Meridians nor Parallels of declination in this Projection, onely the great Meridian of your place is to be found here, becauſe he is an Azimuth as well as a Meridian, for he paſſeth through the Zenith as well as through the Poles of the World, and this Meridian is always diſtant form the *Limb* (or Azimuth of the *Nonageſimus gradus*) as much as the Aſcen-

dant is distant from the East point of the Horizon: for the Amplitude of the Ascendant and the Azimuth of the *Nonagesimus gradus* are always equall, and as the Meridian cutteth the Horizon 90. deg. Westward, from the East point, so doth the Azimuth of the *Nonagesimus gradus* always cut the Horizon 90. degrees Westward from the Ascendant.

This Projection is of excellent use, for getting the Altitude and Azimuth of any or all the degrees of the Ecliptick at once, also for getting the Longitude and Latitude of Planets, Comets, or Stars unknown, by their Altitude and Azimuth Observed.

Chap. IIII.

Of the Horizontal Projection, representing the upper and lower Hemisphears.

Here the *Limb* must be reputed Horizon, and the Center of the *Planisphear* the Zenith of your place. Then may you by one of the Azimuths of the *Reet* represent the Ecliptick in any of his postures, (whatsoever degree be Ascending) and by the *Label* you may presently find the Altitude and Azimuth of every degree thereof. Likewise may you here represent the plain of any Declining-inclining Dial, by some one of the Azimuths: and the Meridian of the Plain by one of the Meridians: by the help whereof you may resolve divers Problemes in Dialling, as shall appear in due place.

The end of the Second Book.

The Third Book.

Of the Resolution of all Spheri cal Triangles, by the

PLANISPHEAR.

Chap. I.

Of the kinds and parts of Spherical Triangles.

1 It is to be known, that Spheri. Triang. are {Rectangular / Obliquangular.

2 A Rectangular Triangle is that which hath one or more Right Angles.

3 A Triangle that hath three right Angles hath alwaies his three sides Quadrants.

4 A Triangle that hath two right angles hath the sides opposite to those angles Quadrants, and the third side is the measure of the third angle. So that of those Triangles which have more Right angles, seldome ariseth any question. But the Right angled Triangle with one Right and two Acute angles, is that which comes most commonly to be resolved.

5 A Right angle is that which containeth 90 degrees, or openeth to one quarter of the circumference of any Circle described from the angular point.

6 All Spherical Triangles not Rectangled are called Oblique-angled. And if they have one angle greater then a Right angle, they be called Obtuse-angled, otherwise they be Acute-angled.

7 In rectangled Triangles the sides including the Right angle be called Legs, the side subtending it is called Subtense or *Hypotenusa*.

8 Either Leg of a rectangled Triangle may be made Basis, (if you will imagine him to lie level) and then the other leg shall be called *Cathetus* or Perpendicular.

9 In

9 In Obliqueangled Triangles, the ſides comprehending the angle given or ſought, are called Legs, and the third ſide the Baſe.

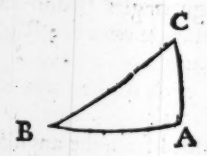
10. In every Spherical Triangle there be (beſide the Area or ſpace contained) ſix containing parts *viz.* three ſides, and three angles: of thoſe ſix there muſt be three alwaies known or given to find out the reſt.

CHAP. II.

Of the 16 *Caſes of Rectangled Triangles. And how they may be reduced to five* Problemes.

IN the Rectangular Spherical Triangle there be five parts onely come into the Queſtion; the three ſides, and two acute angles: becauſe the third (being right) is alwaies known. Of theſe five parts any two being given the reſt may be found.

There be 16 Caſes or *Problemes* about Spherical Triangles, ſix for finding the Legs: four for the *Hypotenuſa:* and ſix for the Angles. See *Gellibrand. Trigonom. Britan.* But we may here reduce them all to 5 Problemes, becauſe our Planiſphear reſolveth alwaies two of them at once. For by two parts given you ſhall preſently get two of the three that are unknown: and if you do but turn the Triangle, you may preſently have the third alſo: as ſhall appear in this book.



The Rectangular Triangle in queſtion ſhall be marked throughout this book with A B C in this maner: ſo that the Baſe ſhall be marked and called B A, the *Cathetus*, or Perpendicular Leg C A, and the *Hypotenuſa*. B C.

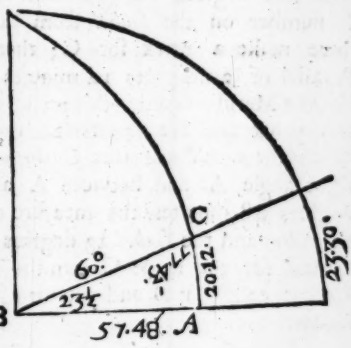
The right angle A, the angle at the Baſe B. the angle at the *Cathetus* C. And note that in the 4 firſt *Problemes* B A ſhall be alwaies ſet upon the Equinoctial line of the *Mater*, C A in a Meridian, B C on the *Label*, and B alwaies at the Center; as you ſhall find in the four next Chapters.

CHAP.

CHAP. III. PROBL. I.

The Legs given, to find the reſt.

SEt B at the Center, B A, on the Equinoctial line of the *Mater*, C A, on that Meridian which croſſeth at A; then lay the *Label* to C, and your Triangle is made. Example. Let B A be 57. degr. 48. min. C A 20 degr. 12. min. I number in the Equinoctial line from the Center toward Meridies the length of B A to 57. degrees 48. minutes, and there I imagine ſtands A. Now becauſe this Baſe endeth between the 57 and 58 Meridians, but neerer to the 58, I muſt imagine a Meridian paſſing between them in his due diſtance which ſhall cut off your Baſe in his due length of 57 degrees $\frac{4}{5}$, and in that imagined Meridian I number upwards from the Equator, by help of the Parallels, the length of the Cathetus C A 20. degr. 12. minutes; at the top of this Cathetus is the place of C, whereto I ſet the *Label*, and the Triangle is made upon the Planiſphear, in ſuch form as the figure here ſheweth.



Now may you number B C the *Hypotenuſa* upon the *Label*, and find it 60. degrees, the angle B hath his meaſure on the *Limb* between the Equator, and the *Label* 23 degrees $\frac{1}{2}$.

Laſtly to find the angle C do but turn the Triangle, ſetting C A on the Equinoctial, and B A on a Meridian, (according to the 1. 8.) and laying the *Label* to B you ſhall find B C 60. degrees as before, and the meaſure of the angle C between the Equator and the *Label* may be reckoned on the *Limb* 77. degr. 43. min.

Note here that in this and all other like caſes, in ſtead of the *Label* you may better uſe one of the Semidiameters of the *Reet*; for they have the ſame graduation, and lie cloſer to the *Mater*.

CHAP. IIII. PROBL. II.

A Leg and the Hypotenuſa *given to find the reſt.*

SEt the *Hypotenuſa* B C on the *Label* from the Center: the given Leg (to be marked C A) in one of the Meridians. Example. In the former Triangle, where the *Hypotenuſa* was 60. degrees, the *Cathetus* 20. degrees 12. minutes. I number on the *Label* from the Center 60 degrees, and there make a prick for C; then I turn this prick to the Parallel of 20. degrees 12. minutes, and the Triangle is made. For the Meridian cutting this prick is *Cathetus*, and hath betwixt this prick and the *Equator* 20. degrees 12. minutes, as the Parallels ſhew. Where this *Cathetus* cuts the Equator ſtands the right angle A, and between A and the Center lies B A, 57. degrees 48. minutes: the meaſure of B is on the limb between *Meridies* and the *Label* 23 degrees 30. minutes.

And for the angle C turn the Triangle. Set C now at the Center, calling it B, and you may find this angle as you did his fellow.

CHAP. V. PROBL. III.

The Hypotenuſa *and an* Angle *given, to find the reſt.*

SEt the *Hypotenuſa* on the *Label*, the Angle given at the Center. Example. In the former Triangle the *Hypotenuſa* was 60. degrees, and the greater angle 77. 43. I number in the *Limb* from *Meridies* toward *Orient* 77. degrees 43. minutes, and there I ſet the *Label*, then I look the 60. degree of the *Label* numbred from the Center, at that 60 degree is C where the *Hypotenuſa* and *Cathetus* meet. Here therefore the Meridian that cuts the *Label* in 60 degrees makes the *Cathetus*: I follow him down to the Equator and find his length 57 degrees 48 minutes, and from the point where he cuts the *Equator* I go ſtraight to the Center, and find 20 degrees 12 minutes the length of B A.

Laſtly for the angle C turn the Triangle, ſetting C at the Center, and calling it B; and you ſhall find C as chap. 3. For

whereas

whereas your *Hypotenuſa* is 60, and your *Cathetus* 20 degrees 12 minutes, lay the 60 degree of the *Label* upon the 20 Parallel, and the *Label* ſhall cut in the *Limb* 23 degrees 30 minutes, the meaſure of the angle C.

Chap. VI. Probl. IIII.

A Leg and an Angle given to find the reſt.

IF the *Leg* be conterminate or adjoyning to the angle given, then make the given Leg *Baſe*, letting it upon the *Equator*; and move the *Label* from the *Equator* toward the Pole, ſo many degr. as the given angle B comes to. Then mark what Meridian cuts the end of the Baſe, that Meridian makes the *Cathetus*: follow him till he croſſeth the *Label*, in that croſſing is the angle C of your Triangle, from whence you reckon the length of the *Cathetus* to the Equinoctial, and the length of the *Hypotenuſa* next way from C to the Center.

And now having all the ſides, to get the angle C you ſhall turn the Triangle, and get him as in the 3 Chapter.

But if the Leg be oppoſite to the Angle given, make the given Leg *Cathetus*, that the angle given may be at the Center.

Example. In the former Triangle I have given the leſs angle 23 degrees $\frac{1}{2}$, and the Leg oppoſite thereto 20. degr. 12. min. I open therefore the *Label* from the Equator to 23 deg. 30 min. on the *Limb*, and mark where he cutteth the 20 $\frac{1}{5}$ Parallel, for there is the angle C of the Triangle; thence you ſhall have a Meridian for the *Cathetus* going to the Equator, whoſe length is 20 degrees 12 minutes: thence in the Equator to the Center is the *Baſe* 57 degrees 47 minutes; and thence in the *Label* to C again, is the *Hypotenuſa* 60 degrees.

And now having all the ſides, to get the angle C, you ſhall turn the Triangle, and get him as in the 3 Chapter.

Chap. VII. Probl. V.

The Angles given to find the Sides.

THis ſhould have been the third Probleme, conſidering what is given. But becauſe the way of reſolving this

caſe differeth from all the former, therefore I have reſerved it to the laſt place.

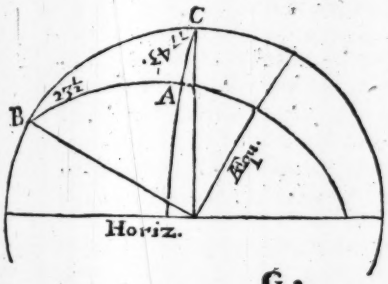
In plain Triangles this caſe is inſoluble. But in Spherical Triangles it may be reſolved on the Planiſphear, two wayes.

1. The firſt way hath M. *Elagrave* 5, 24. He ſets B C on the *Limb* between the Pole of the *Mater* and the Vertex of the *Reet*, B A and C A one on a Meridian, and the other on an *Azimuth* croſſing one another at a Right angle within the *Limb*. Which to do you muſt work thus. Example. In the former Triangle, the Angles are given A 90, B 23, degr. 30, min. C 77, degr. 43, min. Now firſt I will gueſs that the *Hypotenuſa* is 40 degrees, and ſetting the *Zenith* 40 degrees from the Pole, that arch of the *Limb* between *Pole* and *Zenith* I take for my *Hypotenuſa*, yet unknown. At the Pole ſhall be B, and at the *Zenith* C. Then becauſe B is 23 $\frac{1}{2}$ I take the twentie-third Meridian from my *Hypotenuſa* which is on the *Limb*, and between that and the 24th I imagin a Meridian which ſhall make B A of my Triangle. Alſo becauſe the Angle at C is 77, deg. 43. min. I take an imaginary *Azimuth* near the 78th, numbred from my *Hypotenuſa* which is on the *Limb*, and that *Azimuth* ſhall make C A of my Triangle. Now have I the Angles B and C, and three arches of which all the ſides of my Triangle ſhall be made: but whether B A and C A croſs at Right Angles I know not, and therefore I know not yet certainly the length of any ſide. Now to make the Angle at A a Right Angle, mark where your *Azimuth* (which you have taken for C A) cuts the Finiter, and from that point number in the Finiter toward the Center to 90 degrees, and there is the Pole of your *Azimuth*; (*viz.* 12 degrees 17 minutes from the *Limb*) make a prick with ink at that Pole, and then look whether your Meridian 23 $\frac{1}{2}$ (which you took for B A) cut this Pole, which yet he doth not as you will find. Therefore turn the *Reet* till the ſaid Meridian do cut this Pole of the ſaid *Azimuth*, and then you may be ſure that Meridian and *Azimuth*, (wherever they croſs,) do make Right Angles. (By *Pitiſc. Trigonom.* 1, 57) Therefore now have you all the Angles ſet on the Planiſphear, and thereby all the ſides found, *viz.* B C in the *Limb* 60, degr. B A in the Meridian 57 degrees 48 minutes. C A in the *Azimuth* 20 degrees 12 minutes, as they ought to be.

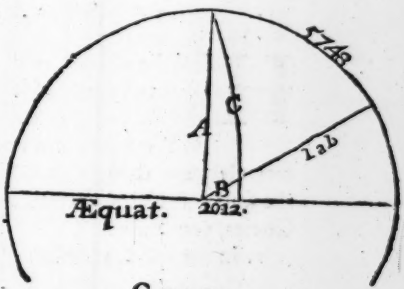
2. The ſecond way M. *Oughtred* uſeth: It is this. For the rectangled

rectangled Triangle whose three Angles be given, you shall frame another oblique Triangle, whose sides shall be equal to the Angles of the first Triangle. And so the Angles of the second Triangle to be found on the Planisphear shall be equal to the sides of the first Triangle, which are inquired. The Triangle which serveth for an Example throughout this Book hath his Angles A 90 degrees. C 77 degrees 43 minutes, B 23 degrees 30 minutes. Here to find the sides, for the Angle A, I take half the Axis of the *Mater* from the Center to the Pole, and that shall be a side of 90 degrees. For the lesser Angle B, I reckon upon the *Label* from the Center a side of 23 degrees 30 minutes, and at the end thereof make a prick, on the *Label*. I turn this prick upon the Parallel from the Pole 77 degrees 43 minutes, and the Meridian there Crossing shall be the third side of this Triangle. Follow this Meridian to the Equator, and from his cutting there to the Center is the measure of the lesser Angle of this second Triangle, which is equal to the lesser Leg of the first Triangle. 20 degr. 12 minutes: likewise the arch of the *Limb* from the Pole to the *Label*, is the measure of the middle Angle of the second Triangle, which is equal to the middle side, that is, to the greater Leg of the first Triangle 57 degrees 48 minutes. And now having found the Legs of the first Rectangled Triangle you may by the first Probleme find the *Hypotenusa* to be 60 degrees. The Rectangled Triangle used in the first way, and the oblique *Quadrantal* Triangle used in this second way, shall appear in such formes on the Planisphear as these figures following do express.

The first Way.



The second VVay.



CHAP. VIII.

How to repreſent and reſolve the Caſes of the four firſt Problemes *of* Spherical *Triangles, divers other wayes.*

ONe way hath been ſhewn for repreſenting any Rectangled *Spherical* Triangle upon the Planiſphear, by the *Label, Equator-line,* and a Meridian, and thereupon to find out the ſides and Angles of any ſuch Triangle.

Now for *Variety* ſake, and for the exerciſe of Learners in the knowledge of the Sphear, and becauſe the ſame Angle ſomtimes may be more diſtinctly repreſented in one part of the Planiſphear then in another, I have thought good to ſet down ſix other wayes, by which the four firſt Caſes of *Spherical* Rectangled Triangles may be pictured on the Planiſphear, and reſolved.

There be three places in the Planiſphear where the Angle B may be placed, whether he be given, or ſought.

1. At the Center, and there his quantity is meaſured by the *Label* or any Semidiameter of the *Reet*, moving upon the *Ring*, thus was B placed in the former Chapters, and ſhall be once more in the firſt *Variety*.

2. At either of the Poles of the *Mater*, where by the Meridians that iſſue thence you may number the quantity of any Angle from 0, to 180.

3. At the *Zenith* or *Vertex* of the *Reet*, where the quantity of the Angle may be numbred by the *Azimuths* in like manner.

CHAP. IX.

The firſt Variety.

HEre the angle B ſhall be at the Center as before; B A on the Finiter, C A in an *Azimuth*, B C in the Axis of the *Mater*. So ſhall you have your Triangle pictured in the ſame form and quantity that he had in the former chapters, though other lines be here uſed. And to reſolve the four firſt Caſes of Rectangled Spherical Triangles with theſe Circles, you ſhall,

1. In the firſt Caſe where B A and C A are given, Number B A from

A from the Center upon the Finiter; where it ends, you ſhall meet an *Azimuth* upon which you ſhall number C A toward the *Zenith*; in the top of C A make a prick with ink for C, and then turn that prick to touch the Axis of the *Mater*. Thus have you all the ſides in view, and the meaſure of the angle B you ſhall find upon the *Limb*, between the Pole and the Finiter. And for C you muſt turn the Triangle as before hath been taught.

2. In the ſecond Caſe B C and C A given, Number B C in the Axis from the Center, and at his end for C make a prick; Then for C A count to what *Almicantar* he will riſe from the Finiter, and turn the *Reet* till that *Almicantar* cut the prick C in the Axis; and the *Azimuth* there croſſing the Axis and *Almicantar* in C ſhall make C A. And between that *Azimuth* and the Center ſhall be B A on the Finiter. B ſhall be meaſured as before. C ſhall be found as before.

3. In the third Caſe B C and B given, Set the Finiter as much from the Pole as the angle B comes to. Then number B C in the Axis from the Center B to C. Thence turn down in the next *Azimuth* to the Finiter and you make C A. Thence turn to the Center, and you cloſe the Triangle with B A. C ſhall be found as before.

4. In the fourth Caſe, if B and B A be given, Set the Finiter to the angle B. as in the third caſe in this chap. and from the Center upon the Finiter number B A. from A go up an *Azimuth* to the Axis, where C ſhall ſtand. From thence go to the Center, and you have compaſſed your Triangle, and all is ſhown by the view, but the angle C, which may be found as before. But if B and C A be given, ſet the Finiter to the angle, as in the third Caſe of this chap. then count in what *Almicantar* C A will end, and follow this *Almicantar* to the Axis, where they meet is the point C. And the *Azimuth* that cutteth there ſhall cut the Finiter in the place of A.

CHAP.

CHAP. X.

The second and third Varieties.

SEt B at one of the Poles of the *Mater* where the Meridians meet; B A on the *Limb* either way B C in a Meridian C A on the *Label*. One Example of the third Case shall suffice. B and B C are given. B is 77 degrees 43 minutes; Number therfore the Meridians from the *Limb* till you come past 77 and almost to 78. and there imagin a Meridian to be drawn for the *Hypotenusa* of your Triangle; That Meridian maketh an angle of 77 degrees 43 minutes with the *Limb*, as the *Hypotenusa* of your Triangle doth with the Base. And because the *Hypotenusa* B C is 60. therfore the 60th Parallel reckoned from the Pole shall determin his length, and cut him off in the point C. Prick the point C (that is, the crossing of the 77 43 Meridian with the 60th Parallel from the Pole) and to that prick lay the *Label*: so that part of the *Label* which lieth between the prick and the *Limb* shall be C A, and the arch of the *Limb* between the Pole and the *Label* shall be B A of the Triangle. So shall all be known but C, which also may be found if you turn the Triangle as before.

Or thirdly, using only the *Reet* and *Label*, Set B at the *Zenith*; B A on the *Limb* of the *Reet*; A C in the *Label*; B C in an *Azimuth*, and you shall make the same Triangle on the *Reet*, that you made last on the *Mater*.

CHAP. XI.

The fourth Variety.

SEt B at the *Zenith* of the *Reet*. B A upon the *Limb* from the *Zenith* to one of the Poles of the *Mater*. C A in the Axtree-line of the *Mater*, B C in an *Azimuth*,

CHAP.

CHAP. XII.

The fifth Variety.

SEt B at one of the Poles of the *Mater*, B A upon the *Limb* between the Pole and *Zenith*, C A in the Axis of the *Reet*, B C in a Meridian.

Note here, that if you ſet the Triangle upon the Planiſphear either of thoſe two laſt wayes, you ſhall find him to be ſet both wayes, and that you haue your Triangle twice found, or two Triangles, each of them repreſenting the Triangle in Queſtion; one is toward the right hand and the other toward the left: And they are both comprehended between the Axletrees of the *Mater* and *Reet*; and the arch of the *Limb* which lies between the two Axletrees is Baſe to them both.

CHAP. XIII.

The ſixth Variety.

SEt the *Zenith* line of the *Reet* in the Equinoctial line of the *Mater*, Then ſet B at the *Zenith*, B A upon the Equinoctial line inwards from the *Limb*, C A in a Meridian, B C in an *Azimuth*.

Thus have you various wayes for deſcribing and reſolving any rectangular Spherical Triangle upon your Planiſphear. If in trying one way you find the points of your Triangle too much ſhadowed with the *Reet*, or that the ſides croſs one another too obliquely, that you can hardly find the point of the angle, then may you trie another way, and you ſhall likely find that fault amended.

Theſe three laſt Chapters you ſhall eaſily underſtand, if you underſtand the former Chapters of this Book. And therefore I thought it needleſs to uſe any further examplification.

CHAP. XIV.

Of the Solution of Oblique angled Spherical *Triangles: And generally of all* Spherical *Triangles.*

THeſe ſix Chapters following might well have been placed before the ſecond Chapter. For howſoever they beſt ſerve Oblique angled Triangles, yet are the Rules general, and may ſerve very well for the ſolution of all *Spherical* Triangles whatſoever. But I like this order well enough, and I think the Reader will have no cauſe to diſlike it.

There be twelve Caſes of Oblique-angled *Spherical* Triangles. But for the *Planiſphear* they are here reduced to ſix. And they be all (unleſs I may except the laſt) as eaſily reſolved upon the *Planiſphear* as the five Caſes of Rectangled Triangles.

Here note that for Oblique-angled Triangles, in all the Caſes following, one ſide ſhall evermore be ſet upon the *Limb* between one of the Poles of the *Mater* and the *Zenith*, of the *Reet*, and the other two ſides ſhall be made, one by a Meridian, and the other by an *Azimuth*; at the meeting whereof is the Angle C, which onely may remain unknown after any Queſtion reſolved, and may be preſently found by turning the Triangle, as before it hapned in the Rectangled Triangles.

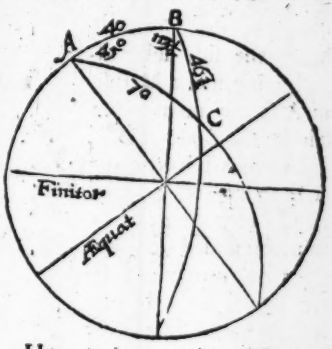
PROB. 1. *Three* Sides *given, to find the* Angles.

SEt one Side, (which you will) upon the *Limb*, between the Pole and *Zenith*, count the ſecond ſide from the Pole by the Parallels, and count the third ſide from the *Zenith* by the *Almicanters*: and know that where the laſt Parallel cuts the laſt *Almicanter*, there is the point of the third Angle C: the Meridian that paſſeth from this point to the Pole is the ſide A C: the *Azimuth* that paſſeth from the ſame point to the *Zenith* is the ſide B C: and the third ſide A B is on the *Limb* between the Pole and *Zenith*. Now may you count the Angles at the Pole and *Zenith* and B: and for the third Angle C, turn the Triangle laying one of the other ſides in the *Limb* between the Pole and *Zenith*, and you ſhall find that Angle alſo, as you did his fellowes. Note that whereas I called the ſides of Rectangled Triangles

gles B A. C A, and B C, that is *Basis*, *Cathetus*, and *Hypotenusa*, I choose here in Oblique-angled Triangles to transpose the letters of the two first sides for distinction sake, calling them A B, and and A C, and the third side indifferently either B C or C B.

Example. Let 40 degrees 70 degrees and 46 degrees $\frac{1}{2}$ be Sides of a Triangle, whose Angles are sought. Now because I would first get the Angles joyning to the side 40 degrees, I mark that side A B, and set A B upon the *Limb*, A at he Pole, and B at the *Zenith*; which I remove 40 degrees from the Pole, according to the length of the side A B. Then because A C is 70 deg. I hold one finger (or a pin) upon the 70 Parallel from the Pole, and because B C is 46 $\frac{1}{2}$ I hold another finger on the 46 $\frac{1}{2}$ *Almicanter* counted from the *Zenith*, and look where this *Almicantar* crosseth the said 70 Parallel, there is C of my Triangle: The Meridian that comes from the Pole to C is the long side of my Triangle A C; I count then from the side A B on the *Limb* how many Meridians lie between A B and A C, and I find that A C is just the 45 Meridian, therefore I say the Angle A at the Pole is 45 degrees. The *Azimuth* that comes from the *Zenith* to C is here the middle side of my Triangle, being in length 46 $\frac{1}{2}$ I count from the side A B of my Triangle on the *Limb* how many *Azimuths* there are to this, and I find that this is the 114 *Azimuth* almost, therefore the Angle B at the *Zenith* is almost 114 degrees (exactly 113. 30. minutes.)

Now to find the Angle C, I turn the Triangle, and set B C, 46 degrees $\frac{1}{2}$ on the *Limb* (changing the letters into A B) And where the 40 Parallel crosseth the 70 *Almicanter*, there I meet with the 39 *Azimuth*, which shews me that the third Angle formerly called C, and now since the Triangle turned marked B is 39 degrees (exactly 38 deg 51. minutes.)



CHAP. XV. PROB. 2.

Two Sides *and an* Angle *comprehended given, to find the reſt.*

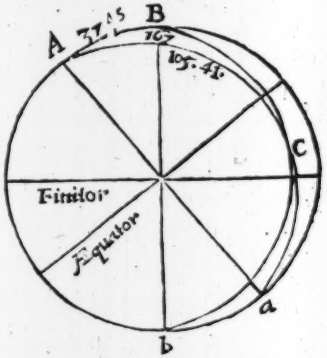
SEt the Angle given at the Pole. and ſet one of the given ſides in the *Limb* between the Pole and *Zenith*, the other given ſide you ſhall reckon on that Meridian which is diſtant from the *Limb* as much as the given Angle cometh to, at the end thereof there ſhall meet you an *Azimuth* which ſhall make the third ſide of your Triangle.

Example. In the former Triangle having A B 40. A C 70 and the Angle comprehended at A 45 degrees, I ſet A B on the *Limb* from Pole to *Zenith*, then becauſe the Angle A is 45 degrees I take the 45 Meridian reckoned from A B, and thereof I take 70 degrees (counting from A the Pole) for my ſide A C: at C in the 70 degree of this Meridian there croſſeth an *Azimuth* which makes my third ſide; this *Azimuth* is the 113 $\frac{1}{2}$ being numbred from A B, therefore the Angle at B is 113 $\frac{1}{2}$, and I finde between B and C in this *Azimuth* 46 $\frac{1}{2}$ for the length of the ſide B C: onely C is now unknown, which you may alſo find by turning the Triangle.

CHAP. XVI. PROB. 3.

Two Sides *and an* Angle *oppoſite to one of them given, to find the reſt.*

SEt the given Angle at the *Zenith* B, the ſide ſubtending it in a Meridian A C, the other given ſide on the *Limb* A B.



Example. I have given A B 37 degrees 45 min. A C 105 degrees 41 minutes: and B 167 degrees 09 minutes: I ſet the *Zenith* B 37 degrees 45 minutes from the Pole A, then becauſe B

is 167 degrees 9 minutes, I count the *Azimuths* from the ſide A B to 167 degrees, and farther 9 minutes, and I know that the *Azimuth* there imagined to paſs (ſet between 167. and 168) ſhall make the ſide of my Triangle B C; but yet the length of B C I know not; and I want ſtill a Meridian for the ſide A C oppoſite to the angle given. Now becauſe A C his length is given (105 degrees 41 minutes, though the Angle A be yet unknown) I take the Parallel 105 degrees 41 minutes, numbred from the Pole A, and where this Parallel croſſeth the 167 *Azimuth*, there I am ſure muſt be the Angle C: and the Meridian paſſing from C to the Pole is the ſide A C 105 degrees 41 minutes: this Meridian lieth between the 12 and 13 number from A B, and ſheweth the Angle A to be 12 degrees 26 minutes: the ſide B C, I may count 68 degrees $\frac{1}{2}$ by help of the *Almicantars*. Now have I three ſides and two Angles, which are more then enough to find the Angle C, when the Triangle is turned.

Note that you may place the known Angle at the Pole as well as at the *Zenith*, and it may be needfull ſo to do when the Angle C of your Triangle would otherwiſe fall under the *Limb* of the *Zodiaque*.

Note alſo that the Angle C may ſometime fall under the Finiter, where the *Azimuths* faile. As if you had ſet the Angle 167 degrees at the Pole, the oppoſite ſide 105 degrees 41 minutes had been ſet in an *Azimuth*, and C had been beyond the Finiter: your remedie in this caſe is to ſet *Nadir* in the place of *Zenith*, ſo ſhall C fall among the *Azimuths* juſt as you would have him. Example. Set 37 degrees 45 minutes between the Pole and *Nadir* (*a b*) count the Angle given at the Nadir *b* 167 degrees 9 minutes, and his ſupplement 12 degrees 51 minutes, for A C count *a C* the ſupplement thereof, and you ſhall find *b C* 111 $\frac{1}{2}$, whoſe ſupplement is B C 68 $\frac{1}{2}$.

Note thirdly, that if the angle given in this chapter be acute, then if you place the known Angle at the *Zenith*, the Parallel may croſs the *Azimuth* twice; or if you place the known Angle at the Pole, the *Almicanter* taken to find out the oppoſite ſide, may croſs the Meridian twice; and ſo it may be doubtfull in which interſection the Angle C ſhall be found: That you may diſcover, if you examine which agrees beſt with the other parts of the Triangle being turned; or if you reduce this Triangle to

two Right-angled Triangles, by letting fall a Perpendicular. Of which ſee the laſt Chapter.

CHAP. XVII PROB. 4.

Two Angles *and the* Side *comprehended between them being given, to find the reſt.*

SEt the ſide given between the Pole and *Zenith* on the *Limb*, then count one Angle among the Meridians, the other among the *Azimuths*, and where the Meridian and *Azimuth* bounding the ſaid Angles meet, there is the point of the Angle C, and all is known but the Angle C, which you may find alſo, if you turn the Triangle.

Example. In the 14th Chap. The Angle A was 45 B 113 $\frac{1}{2}$ the ſide A B comprehended 40. Having ſet the *Zenith* 40 from the Pole, I ſeek the 45th Meridian from A B, and the 113 $\frac{1}{2}$ *Azimuth* from A B, and where they croſs is C. Now may I number A C by the Parallels 70, and B C by the *Almicantars* 46 $\frac{1}{2}$. C may now be found by any of the 3 former Problemes, if you turn the Triangle, and ſet C at the Pole, or at the *Zenith*.

CHAP. XVIII PROB. 5.

Two Angles *and a* Side *oppoſite to one of them given, to find the reſt.*

SEt the Angles given, as A, and B, at the Pole and *Zenith*; the known ſide, as B C in an *Azimuth*; Count among the Meridians the Angle oppoſite to the known ſide, and having found the Meridian that boundeth him, lay a finger or a bodkin point thereon; then count the other Angle among the *Azimuths*, and when you come to the *Azimuth* that boundeth him, becauſe that *Azimuth* maketh the known ſide of your Triangle, you ſhall number his length from the *Zenith*, and at the end therof make a prick, then turn about the *Reet* till this prick in the *Azimuth* touch the Meridian before found; and then is your Triangle formed on the Planiſphear, and all is known: but the Angle C to be found as in the former Chapters.

Example. Let be given A 45 degrees B 113 $\frac{1}{2}$ B C 46 $\frac{1}{2}$. I

count

count from A B to the 45th Meridian, upon which I lay my finger, that he get not away for he muſt make my ſide A C, then I look the 113 ½ *Azimuth* (from A B) to ſtand for the given ſide: and becauſe his length given is 46 ½ therfore in this 113 ½ *Azimuth* at 46 ½ below the *Zenith* I make a prick: then I turn the *Reet* till this prick touch the 45th Meridian, there at that touch muſt C ſtand; thence to the Pole is the ſide A C 70, and on the *Limb* I have the ſide A B 40. C is to be had by turning the Triangle, as in every of the former Problemes.

CHAP. XIX PROB. 6.

Three Angles *given to find the* Sides.

THis Caſe comes very ſeldome in uſe. Yet that our Method of Trigonometry by the Planiſphear may be compleat, and that no Probleme that is ſoluble may be left here unreſolved, I ſhall ſhew the ſolution of this Probleme alſo. Mr *Blagrave*, it ſeemes, never attempted this, contenting himſelf that he had found the way to reſolve this Probleme in Rectangled Triangles, which alſo he had once given over as impoſſible. *Blagr.* Book 5, 24.

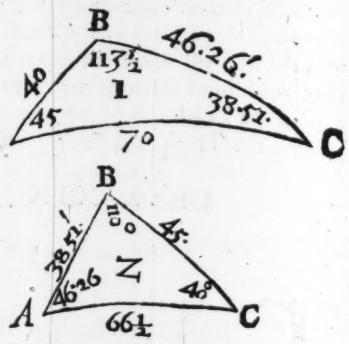
For reſolving this Probleme it is to be known that if you go to the Poles of the 3 great Circles wherof your Triangle is made, theſe Poles ſhall be the angular points of a ſecond Triangle; and the two leſſer ſides of this ſecond Triangle ſhall be equal to the two leſſer Angles of your firſt Triangle; the greateſt ſide of the ſecond Triangle ſhall be the ſupplement of the greateſt Angle of the firſt Triangle (that is, ſhall have as many degrees and minutes as the greateſt Angle of the firſt Triangle wanted of 180 degr.) ſee *Pitiſcus Trigonometry Lib.* 1. *Prop.* 61.

This ſecond Triangle therfore (all whoſe ſides are known from the Angles of the firſt) you ſhall reſolve by the firſt Probleme of Oblique angled Spherical Triangles. Chap. 14. And having by that Probleme found the Angles of this ſecond Triangle, „ know that the 2 leſſer Angles of the ſecond Triangle ſhall „ be ſeverally and reſpectively equal to the two leſſer ſides „ of the firſt Triangle. (and the leaſt Angle to the leaſt ſide, „ the middle Angle to the middle ſide) and the greateſt An- „ gle of this ſecond Triangle being ſubtracted out of 180 degr.

„ ſhall

„ ſhall leave you the greateſt ſide of your firſt Triangle.

Example. If the Angles be given 113 ½ degr. 45 degr. and 38 degr. 51 minutes, and the ſides be enquired. Draw by aime a rude Scheam of this firſt Triangle, writing in the Angle A 45 degr. in B 113 ½ in C 38 degr. 51 minutes, ſuppoſing theſe ſides yet unknown: then draw under this by aime alſo, a Scheam of the ſecond Triangle, ſetting his Baſe Parallel with the Baſe of the firſt, and making the Baſe of the ſecond ſhorter then the Baſe of the firſt. Set alſo B at the Vertical Angle, and A C at the Baſe; as in the firſt Triangle. Then ſay,



Becauſe A in the firſt Triangle is 45 degr. therefore in the ſecond Triangle B C (ſubtendeth A) ſhall be 45 degr. And becauſe C in the firſt Triangle is 38 degr. 51 min. therefore in the ſecond Triangle the ſide A B (which ſubtendeth C) ſhall be 38 degr. 51 min. And becauſe B the greateſt Angle in the firſt Triangle, is 113 ½ therefore in the ſecond Triangle the ſide A C (which ſubtendeth B) ſhall be the ſupplement thereof, *viz.* 66 ½. Write now upon the ſides of this ſecond Triangle the quantities of the ſides, ſo is your ſecond Triangle ready to be reſolved by the firſt Probleme of Oblique-angled Triangles, whereby you ſhall find the Angles of the ſecond Triangle, as I have expreſſed them in the Scheam. A 46, 26 min. C 40, B 110 degrees.

Now laſtly, I ſay theſe Angles of the ſecond Triangle thus found, give me the ſides of the firſt Triangle, which I ſeek, in this manner.

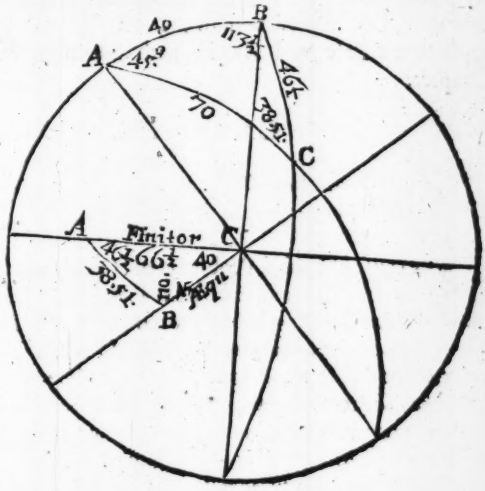
In the ſecond Triangle.		In the firſt Triangle.
A is 46. 26.		B C is 46. 26.
C is 40. 00.	Therefore	A B 40. 00.
B is 110. 00		A C 70. 00. Supplement of 110 degrees.

And thus by all the Angles given, we have found out all the ſides, which was required.

Now would you ſee where this ſecond Triangle dwells in the

Plani-

Planiſphear, by whoſe help we have found out the ſides of the firſt? That I will now ſhew you; becauſe many may be as glad to know it as I was when I firſt found it. Having then the Angles of your firſt Triangle given, and his ſides alſo now found; place him as in the 14 Chap. A B,40 in the *Limb*, A C 70 in the 45th Meridian. B C 46 degr. 26 min. in the $113\frac{1}{2}$ *Azimuth*. Then you ſhall ſay, Becauſe the Center of the *Planiſphear* is the Pole of the arch A B, therefore at the Center ſhall ſtand the Angle C, which A B ſubtendeth: Next follow the $113\frac{1}{2}$ *Azimuth* (which maketh B C of your Triangle) to the Finiter, and from the poin[t] where he toucheth the Finiter you ſhall number in the Finiter to the Center $23\frac{1}{2}$, and number on $66\frac{1}{2}$ more beyond the Center to make up 90, and there is the Pole of the arch B C. Therefore there ſhall ſtand the Angle A, which B C ſubtendeth. Then follow the 45th Meridian to the Equator, and thence count in the Equator 45 degr. to the Center; and 45 degr. more beyond, which make 90: there is the Pole of the arch or ſide A C. Therefore there ſhall ſtand the Angle B which A C ſubtendeth. Here you ſee your ſecond Triangle made by the Poles of the firſt adjoining to the Center of the *Planiſphear* under the Finiter: onely the ſide A B is wanting: To get that, prick A and B with ink on the *Mater*, if your *Planiſphear* be metal; and when they be drie (if you can have patience to tarry ſo long,) turn about the *Reet* till ſome one *Azimuth* or other do cut both theſe pricks,



which here the 48th or 49th from the *Limb* will make a ſhift to do (if your *Zodiaque* do not obſcure one of the pricks) and in this *Azimuth* you may number between the pricks 38, 51. for the length of the ſide A B. Thus I have ſhewed you how all the ſides and the Angle (C) of the ſecond Triangle (made between the Poles of the firſt Triangle) may be found in his proper place where he dwells in the Sphear, below the Finiter; and how to find both theſe and all the reſt, by hoiſing up this Triangle to the Pole and *Zenith*, hath alſo been ſhewed in this Chapter.

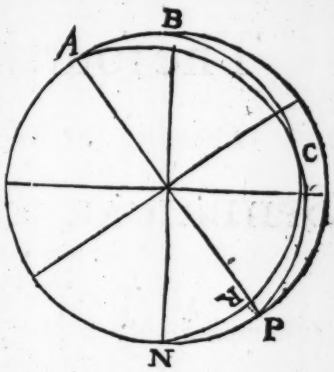
CHAP. XX.

How to reduce an Oblique angled Triangle to two Rectangled Triangles, by letting fall a Perpendicular.

BEcauſe the third Probleme of Oblique angled Triangles cannot be reſolved by the Canon of Sines and Tangents without letting fall a Perpendicular, and becauſe in that caſe the croſſing at the Angle C is oft ſo Oblique that you cannot define the Angular point certainly, and becauſe in the *Method* for reſolving the third Probleme one of the ſides of the Triangle hapneth ſome times to make two interſections with the Parallels or *Almicanters*, and there may be doubt which of theſe interſections is to be taken for the Angle C. Although I there ſhewed another way to reſolve that doubt, yet I will ſhew you alſo how to reſolve it, and to remedie the inconveniences aforeſaid, by letting fall a Perpendicular. And it ſhall ſuffice to ſhew you this in one example, which if you mark and be acquainted with the four firſt Problemes of Rectangled Spherical Triangles, you ſhall be able to do it in any other needfull caſe whatſoever. Take therefore the Triangle of Chap 16. where we had given A B 37.45 minutes, A C 105. 41. minutes. B 167. 9 min. you muſt obſerve that the Perpendicular ought to fall from the end of a known ſide, and to ſubtend ſome known Angle, which here cannot be, becauſe both the Angles at the Baſe A C are unknown.

Continue therefore the ſides A C and B C to Semicircles, and you ſhall have a ſecond Triangle N P C, in which N P is equal to A B. N C is ſupplement of B C. P C ſuplement of A C: N ſupplement of B. C is common to both Triangles.

Here



Here then in the ſecond Triangle N P C. let the Perpendicular fall from P upon the Baſe N C, ſo have you two Rectangled Triangles, P R N, and P R C.

In the Triangle P R N you have (beſide the Right Angle R) the Angle N 12. 51 minutes. (ſupplement of B) and the *Hypotenuſa* N P 37. 45 minutes; and ſo may find all the reſt of this Triangle, by the third Probleme of Rectangular Spharical Triangles, *viz.* P R 7. 49 min. $\frac{1}{2}$ N P R 79, 49 min. and R N 37 degrees, which had,

In the Triangle P R C, by the ſecond Probleme of Rectangular Spharical Triangles you may find R C 70 degrees (which added to R N maketh N C 111 $\frac{1}{2}$, whoſe ſupplement is C B 68 $\frac{1}{2}$) C 8 degr. $\frac{1}{2}$, C P R 88 degr. which added to N P R maketh the whole Angle C P N 167,47. which being ſubducted out of 180 degr. leaveth the ſupplement thereof C A B 12.13 min. as I find it by my Planiſphear; and by exact calculation it may be 12 26 minutes.

Thus have you a perfect *Method* of reſolving all Spherical Triangles by the Planiſphear.

The end of the Third Book.

The fourth Book.

Shewing the Solution of the SPHERICAL PROBLEMES, Both *Aſtronomical*, *Aſtrological*, and *Geographical*, by the PLANISPHEAR.

CHAP. I. The Preface.

THe beſt method (in my judgement) for ſetting down the Problemes of the Sphear *is, to ſet them in ſuch order, that the former may be* Præcognita *to the latter, and the latter preſuppoſe the knowledge of the former. This moſt* Authors *have uſed. But this method here aimed at, perhaps is not alwaies kept exactly. Becauſe where one Triangle ſerves to reſolve divers* Problemes, *I was willing to make an end with him ſometime before I meddled with another, for avoiding the multiplicity of* Chapters, *and repetition of the ſame* Schemes.

THere be in the Sphear five famous Triangles, by the knowledge whereof moſt *Aſtronomical Problemes* are reſolved, inſomuch that if you be but well verſed in the general *Problemes* of *Trygonometry* ſet down in the former Book, and have acquaintance with theſe five Triangles in the Sphear, you will be able to reſolve moſt of the following *Problemes* without any further help.

Of

Of thoſe five Triangles three are Rectangled, which ſhall be here denominated from their *Hypotenuſa's*.

1. The Ecliptical Triangle, whoſe *Hypotenuſa* is an arch of the *Ecliptick*, his Legs are arches of the *Equator*, and a Meridian: he ſerveth eſpecially for Queſtions of the Suns Longitude, Right Aſcenſion, and Declination, with ſome others. See this Ch. 6 &c.

2. The *Horizontal* Triangle, whoſe ſides, are arches of the *Horizon*, *Equator*, and a *Meridian*. He ſerveth eſpecially for Queſtions of the Suns Amplitude, *Aſcenſional* difference, and Declination, and of the Latitude of your place. See this Chapter 14.

3. The *Azimuthal* or *Parallactical* Triangle, whoſe ſides are arches of an *Azimuth*, the *Ecliptick*, and a Circle of Longitude: he ſerveth eſpecially to find the Moons *Parallaxes* in Altitude, Longitude, and Latitude. See this Chap. 64.

4. The other two are *Oblique angled*. One I uſe to call the *Complemental* Triangle, becauſe all his ſides be complements, *viz.* the Complement of Latitude, of Declination, and of Altitude. He ſerveth chiefly to find the Altitude, *Azimuth*, and Hour. See this Chap. 24.

5. The laſt, I uſe to call the *Polar* Triangle, becauſe one ſide of him is evermore the diſtance of the Poles of the World, and of the *Ecliptick* (23 degrees $\frac{1}{2}$) his other ſides are a Meridian, and a Circle of Longitude. He ſerveth chiefly to find the Longitude and Latitude, the Right *Aſcenſion* and *Declination* of the Stars. See this Chap. 34.

Chap. II.

How to find the Altitude of the Sun or Stars, by Obſervation, with the Planiſphear. *Alſo what faſhion is beſt for* Sighst.

THe *Planiſphear* may here ſupply the office of a Quadrant, (which is the fitteſt and moſt common Inſtrument for taking Altitudes) For the *Planiſphear* is divided into 4 Quadrants, and if you hang a plumb-line at the Center, it may ſerve any of them. Set your Sights to one of the Semidiameters of the *Mater*, and turn him ſo to the Sun that the Sun may ſhine through the Sights; then ſhall the plumb-line (if

it hang Parrallel to the *Planiſphear*, neither bearing upon it, nor hanging off from it) ſhew in the loweſt Quadrant of the *Limb* the degrees of Altitude. But becauſe the Quadrants may be ſmal, I have ſhewed you a way how to make them ſerve your turn as well as if they were of double Semidiameter, Book 1. 10. whither I refer you.

My Sights for the Sun and Moon I have deviſed to make thus. Let them be about an inch ſquare for a *Planiſphear* of a foot Diameter: And in the middle of that ſight next you (which muſt be a thin plate) let a very ſmal hole be drilled quite through: in the middle of the Sight next the Sun, bore an hole as big as a Peaſe, or bigger, whoſe Center muſt anſwer the ſmal hole in the other Sight, then croſs the Center of the hole in the Sight next the Sun with an hair, or fine thrid, ſo that the thrid may run level or Parrallel with the *Horizon*, when you uſe the Sights. When you turn the Sights toward the Sun, and the ſhadow of the thrid fall upon the ſmal hole of the lower Sight, you ſhall ſet or hold a white paper about a ſpan behind the lower Sight, upon which paper you ſhall perceive a ſmal Image of the Suns body, and likewiſe of the thrid cutting through the midſt of him very diſtinctly. And here you ſhall obſerve that the image of the thrid moveth upon the image of the Sun in the paper, contrary to the motion of the ſhadow of the thrid upon the lower Sight; for when the ſhadow of the thrid toucheth the bottom of the Sight-hole, the image of the thrid ſhall touch the top of the Suns image on the paper, and contrarily. But when the ſhadow of the thrid cutteth the middle of the Sight-hole, then ſhall the image of the thrid always cut the middle of the image of the Sun upon the paper exactly and clearly. Alſo you ſhall obſerve that though the Diameter of the Sun be always more then 30 min. yet the Diameter of the image cannot be obſerved here to be much above 20 min. as you may meaſure by the min. of the Quadrant which the plumb-line paſſeth over, while the image of the thrid paſſeth over the image of the Sun: whither the Diameter of the Suns image on the paper be diminiſhed by reaſon of the thickneſs of the plate through which the beams paſs, or becauſe the image on the paper is ſmal, the beginning and end of the Obſcuration by the image of the thrid, cannot be preciſely obſerved, for the preſent, I leave to Optical men to enquire: Alſo what is the reaſon why the image of the thrid moveth contrary

to

to the motion of his ſhadow, is a queſtion of ſome difficulty: My reſolution is, becauſe that image is a ſpecies which paſſeth through the Sight-hole with the ſpecies of the Suns body: For when the ſhadow of the thrid falleth upon the lower part of the Sight-hole, then certainly the upper part of the Suns body is above the obſcuration of the thrid, and the lower edge is Eclipſed at the Sight-hole. Now the wayes of the Suns body thus Eclipſed on the lower ſide, paſſing through the Sight-hole, muſt needs be there decuſſated, ſo that the wayes or beames comming from the lower part of the Sun ſhall make the higher part of the image on the paper, and contrarily; as appeareth when an Eclipſe of the Sun is obſerved by a *Teleſcope*, or by a ſmal hole, letting the beames into a dark room: For the reaſon here and there is the ſame. I have uſed thoſe Sights for the Sun and Moon almoſt theſe 20 years paſt, and (for ought I could ever read or hear) they are of my own invention, and I have not met with any device more commodious to me for this purpoſe.

For the Moon, you muſt ſet your eye to the loweſt Sight-hole, and let the thrid cut the middle of her body. For the Stars, if your eye cannot diſcern them by the thrid, you muſt behold them by the edges of the Sights both above and below. Or if you would obſerve the Stars Altitude by ſome larger Inſtrument, I adviſe that the Sight next your eye be a broad plate 4 or 5 inches ſquare, in the middle whereof you ſhall cut a window whoſe length may be near 2 inches, and his breadth or height about an inch or more, ſo that your eye may be well ſhadowed, and yet have free ſcope through the window to find the Star. Let the upper Sight be a Cylinder or ruler ſet Parrallel to the lower Sight, and his breadth be equal to the window almoſt, but narrower by a few minutes as 2 min. or 4 min. when you looking through this window can ſee the Star appear alike on both ſides, the upper Sight, then is your Inſtrument right ſet, and the plumb-line ſhall ſhew you his Altitude as before. Note that for all curious obſervation of the Sun or Stars, your Inſtrument muſt be ſupported with a Tripos, or like device, that it may be ſteddy, and that the apparent Altitudes of the Sun and Moon muſt be corrected according to the Table of Parrallax and Refraction. The fixed Stars have Refraction, but no Parrallax ſenſible. The quantity of the Parrallax is to be added, and the quantity of the Refraction to be ſubtracted alwayes from the apparent Altitude found, ſo ſhall you have the true Altitude.

of

Here followeth an Abridgement of *Lanſbergius Tables* of Refraction and Parrallax of the Sun, as much as this Inſtrument may need, for the reſt go to *Lanſbergius* or *Tycho Brahe's* Tables at large, where you ſhall find the Moons Parrallax in the Horizon, to be ſometimes 51 minutes, ſometimes 1 deg. 7 min. at 70 degrees of Altitude, between 18 deg. 24 min. Here Refraction is as the Sun.

Alt. ☉	*Parall. mi. ſec.*	*Refr. mi. ſec*
0	2 18	34 00
5	2 18	14 00
10	2 16	8 15
15	2 13	6 00
20	2 10	4 33
25	2 05	3 12
30	2 00	1 51
35	1 53	0 54
40	1 46	
45	1 38	
50	1 29	
55	1 19	
60	1 09	
65	58	
70	47	

CHAP. III.

To finde a Meridian line.

STrike a ſtraight line upon a Table or any *Horizontal* plain: and lay your *Planiſphear* ſo that one of the Diameters of the *Mater* may lie in that line. Then take the Suns Altitude: the Altitude would be taken at leaſt 2 hours (the more the better) before noon: and note, that if you take it between 29 and 30 degrees you ſhall be troubled neither with Parrallax nor Refraction, becauſe the Suns Refraction and Parrallax be equall at the Altitude 29 degrees 26 minutes. The Altitude taken, you ſhall immediately lay your *Planiſphear* in the poſture aforeſaid; and turning the *Label* to the Sun, make a prick in the *Limb* where the *Label* cutteth: And when the Sun comes to the ſame Altitude after-noon, your *Planiſphear* laid as before, turn your *Label* to the Sun, and where he cuts make a ſecond prick in the *Limb*. Then divide equally the Arch of the *Limb* comprehended between the pricks: and to the middle thereof lay the *Label*, and it ſhall point full North and South. Look then through your Sights; and if you ſee any Steeple, Pinacles, Chimney, Tree, or ſuch mark, at a good diſtance in the line of Viſion, you may note him for a South-mark, or for want thereof ſet up a ſmaller mark neerer hand. But note alſo that this may beſt be done when the Sun is in or neer the Summer *Tropick*, for neer the *Equator* he changeth his Declination ſo faſt, that it may cauſe you an error of a few minutes, unleſs you make allowance for it.

Note

Note, that all lines Parallel to your Meridians are Meridians.

2. *Another way.*

Having taken the Altitude of the Sun, or a Star, at a good distance from the Meridian; presently lay your *Planisphear* flat, and turn the *Label* to the Sun, or Star, as before. Then by the Altitude taken, get the *Azimuth*; (by chap. 24 or 27 of this book.) Then remove your *Label* (Eastward; if the Sun or Star were Westward from the Meridian; or Westward if the Sun or Star be in the East Hemisphear;) so many degrees as the *Azimuth* cometh to, and your *Label* shall be in the Meridian.

3. *A third way.*

When the great *Wain* is seen under *Cynosura*, (the Pole Star) observe with your eye the distance of the *Thill-horse*, called *Alioth*, from the next wheel of the *Wain* and setting that distance (by aime) in 5 parts, observe by a plumb-line when *Alioth* drawes neer to be in the same Perpendicular with the Pole Star. For when he wanteth but one of those 5 parts to come into the *Perpendicular*, then is the *Pole-star* in the Meridian over the *Pole* in our age: at other times of the night, the *Pole-star* may be 4 degrees wide, and in one hour neer the Meridian he changeth his *Azimuth* above one degree.

4. *A fourth way.*

Because the distance of the *Pole-star* from the *Pole* is now 2 degrees 30 minutes, and the *Pole* is in the circle or line which passeth from the *Pole-star* neer *Alioth*, as before; you may by guess cut off from that line 2 degrees 30 min. and in that Section you have the *Pole* at any time. This way may be used abroad in the fields, where you cannot stand upon exactness; and herein you shall miss very little, if you accustome your self to observe the distances of the Stars about the *Pole*.

Chap. IIII.

To Observe the Azimuth *of the Sun or Stars.*

LAy your *Planisphear* upon an *Horizontal* plain or Level, and his Meridian on the Meridian line of your Place, found by the last Chapter. Then turn your *Label* that the Sun may cast the shadow of one Sight upon the other, or directly towards it, or till the shadow of a plumb line

cut both the Sights alike, then doth the *Label* ſhew the *Azimuth* in the *Limb*. For the Stars, you muſt ſo direct the Sights by your eye, that their edges may touch the Viſuall line that comes from the Star to your eye: and if your long Sight prove too ſhort, turn him toward your eye, and inlightning the ſhorter Sight by a candle held behind you, mark where the edge of the long Sight cuts both the edge of the ſhort Sight, and the Star; for there is your *Label* in the *Azimuth* of the Star, which you may count on the *Limb*.

Note that if you ſeek the *Azimuth* to get the hour, you ſhall find it moſt eaſily when the Sun or Stars are neer the *Horizon*: and then you ſhall not be troubled with their Refraction. But there is moſt uſe of obſerving *Azimuths* neer the Meridian, becauſe there the *Azimuth* changeth apace, the Altitude very ſlowly: Yet if you may chooſe, chooſe to take Altitudes rather then *Azimuths* (ſo you come not within 2 or 3 hours of the Meridian) becauſe the Sights ſerve all Altitudes with like facility, and you may ſooner have a true plumb line any where, then a true *Horizontall* plain, and a true Meridian line.

Caap. V.

To find the Suns Longitude.

The Longitude of the Sun is the arch of his diſtance from ♈ o in the *Ecliptick*: or it is the angle made at the Pole of the *Ecliptick* comprehended between the circle of Longitude paſſing through ♈ o, and another Circle of Longitude paſſing through the center of the Sun: for the ſaid arch of the *Ecliptick* is always the proper meaſure of this Angle. And becauſe the Suns center never hath Latitude, therefore for the Sun you ſhall enquire the arch; but contrarily, for the Stars which have Latitude, you ſhall require the Angle: and they be both (as was ſaid) of one meaſure.

The Suns Longitude (Arch or Angle) is preſently found by the *Ephemeris* upon the *Limb* of your *Planiſphear*, for if you lay the *Label* upon the day of the Moneth, it ſhall cut the degree of the Signe alſo in which the Sun is, and that is his Longitude: in doing whereof, you ſhall obſerve the cautions given Lib. 1. 8. to which I refer you.

Note

Note here, that the Longitude of a place in *Geographie* is the Angle at the Pole of the World, comprehended between the first Meridian (passing by the hither side of S. *Michals* Island, which is the neerest of the *Azores*) and the Meridian of the Place: and this Angle hath his measure in the *Equator*.

Chap. VI.

The Suns Longitude, Declination, Right Ascension, *any one of them given, to find the rest in the first* Projection.

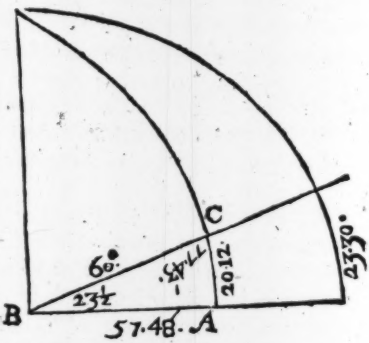
What the Suns Longitude is, hath been shewed chap. 5. His Declination is his distance from the neerest point of the *Equator*; and therefore is alwaies measured in an Arch of that Meridian which hapneth to pass through the center of the Sun, and always cuts the *Equator* at right Angles, as do all the Meridians.

The Right Ascension of the Sun is the angle at the Pole of the World comprehended between that Side of the *Colurus Equinoctiorum* which cuts the intersection of the *Ecliptick* with the *Equator* in ♈ 0, and the arch of another Meridian which passeth through the center of the Sun. And note, that this angle may increase above 180 degrees, even to 360 degrees, though every angle, properly so called be less then 180 degrees, and never more then 90 degrees comes into the Triangle: for if you number backwards or forwards from either of the Equinoctiall points, you shall have like arches of Right Ascension answering to like arhces of Longitude and Declination; so that having found the Right Ascension in any one Quadrant, or the complement therof, you shall find the whole Right Ascension from ♈ 0 by adding one, two, or three whole Quadrants to the Right Ascension found, or to the complement therof, as by the view of your Planisphear you shall presently know how to do better then by more words. Otherwise thus. The Right Ascension of the Sun is an arch of the Equator comprehended between the *Vernal Equinox* and that point of the Equator which riseth with the Sun in a right Horizon. A right Horizon is where the Equator passeth through the *Zenith*, and maketh right angles with the Horizon, and consequently, where the Poles have no Elevation: For from that posture of the Sphear in which the

Equator riſeth upright, is the term of Right Aſcenſion borrowed: I would, if I might, call it rather Equation; becauſe it is numbred on the Equator, and ſerves for the Equation of naturall days, and may as eaſily be found in any Sphear as in a right Sphear, ſince the Horizon of a right Sphear limits the Right Aſcenſion only becauſe that Horizon falls in with a Meridian, and the Meridians do limit it in all parts and poſtures of the Equator, without any reſpect to the Horizon at all. But the old term hath ſo long inured, that I beleeve it will not be changed without better Authority.

The Ecliptical Triangle.

Theſe definitions premiſed, you ſhall know that theſe three arches, *viz.* of Longitude in the *Ecliptick*, of Right Aſcenſion in the Equator, and of Declination in a Meridian, do make up a notable Rectangled-Triangle in the Sphear, like unto that which was made the common Example, in all the five Problemes of Rectangled-Triangles. Book 3, 3. &c.



For there B C is the Longitude (in ♈ ♉ ♊) 60. degr. C A the Declination 20 degr. 12 min. B A the Right Aſcenſion 57 degr. 48 min. A is known a right angle, B is known, the angle of the Suns greateſt Declination, which for our age is 23 degr. 30 min. Now if but one of the Sides be given, you may find the other two by the Problemes of Rectangled Spherical Triangles.

But to ſee your Triangle, and reſolve him in his proper lines, Go to the *Mater* of your Planiſphear, and take him there in the firſt Projection. There number 60 the Suns Longitude in the *Ecliptick* line of the *Mater* from the Center outward. Where 60 endeth, there is C of your Triangle, and the Meridian that meets you there is C A the arch of Declination; follow him to the Equator, and you ſhall find by his graduation he is 20 degr. 12 min. Long. thence turn in the Equator to the Center, and you make B A the Right Aſcenſion 57 degr. 48 min. ſo have you the

the true picture of your Triangle in his proper place. Obſerve your Triangle now, and you may ſee A is a right angle, for at ſuch angle all the Meridians cut the Equator. B is 23 $\frac{1}{2}$, for ſuch an angle the *Ecliptick* dayly maketh with the Equator, as the arch in the *Limb* comprehended between them ſhewes. Now take for given any of the three Sides, and you have the reſt. Take the Longitude for given (and be it 60 degr. as before, or 70 degr. or what you will) and you may find the Declination, and Right Aſcenſion as before. Let the Right Aſcenſion be given; then ſetting a needles point in the end thereof A, you may thence in a Meridian trace out the Declination C A to the *Ecliptick*, and the Longitude B C thence to the Center, every Side being divided into his whole parts or degrees. If the Declination be given, ſay, Becauſe the 20th Parrallel almoſt muſt cut off C A (the arch of Declination) in C, therefore I follow the Parallel 20 $\frac{1}{5}$ to the place where he cutteth the *Ecliptick* and there comes the Meridian that ſerves my turn; and I may go down by him to the Equator, (as you would go down a ladder counting the rounds or degrees as you go) and ſo on, round my Triangle, and I need no more. For obſerve it when you will in the uſe of this Planiſphear, if you can find the way to go round your Triangle, you have all the Sides meaſured to your hand, and evermore one Angle alſo, moſt commonly two, and the angle C onely left unknown.

But admit the Sun be in ♌ 0, then is his Longitude 120. degrees, and he is come back from the *Solſtice* in your Planiſphear as many degr. as he wanted of it before. Here the Triangle is equal to the former, and reſolved in like manner. The Declination is the ſame as before: But the arches of Longitude and Right Aſcenſion in the Triangle are ſupplements of the true Longitude and Right Aſcenſion; ſhewing what the Sun wants of the Longitude and Right Aſcenſion 180, in ♎ 0. wherefore ſubtract the Baſe of the Triangle 57 degr. 48 min. from a Semicircle, or 180 degr. and you ſhall leave 122 degr. 12 min. the Right Aſcenſion of ♌ 0. or number in the Equator from the Center the way in which the Right Aſcenſion hath increaſed, that is firſt to the *Limb* (which here is *Colurus Solſtitiorum*) 90 degr. then back again to A the Right angle of your Triangle, and you have 32 degr. 12 min. to be added thereto. The Sum is 122 degr. 12 min. the Right Aſcenſion, as before. If you obſerve this Example,

you will eaſily perceive, that when the Sun is paſt ♎ 0. the Triangle will be on the other ſide the Center, and between ♎ and ♑ you muſt add to the Right Aſcenſion and Longitude found within the Triangle 180 degr. and in the laſt Quadrant between ♑ and ♈ (where the Right Aſcenſion again increaſeth inwards) you muſt add 270 degr. to the complement of Right Aſcenſion found in the Triangle, and take the ſum, or elſe ſubduct the Right Aſcenſion found in the Triangle from 360 degr. and take the reſidue for the Right Aſcenſion.

Chap. VII.

To do the ſame in the ſecond Projection, more eaſily.

IN the ſecond Projection where the Center is the Pole of the World, and the *Limb* Equator, you ſhall find the *Ecliptick*, fairly drawn upon the *Reet* and diſtinguiſhed into his quarters and degrees. Remember now from the former chap. that the Ecliptick, Equator, and a Meridian, muſt make your Triangle; and know that the *Label* ſupplieth the place of the Meridians.

If the Longitude or Right Aſcenſion be given, lay the *Label* on the degree given (in the *Ecliptick* for Longitude, or in the *Limb* of the *Reet* for Right Aſcenſion) and your Triangle is made, and you may preſently ſee your deſire.

If the Declination be given, conſider in what quarter of the *Ecliptick* the Sun is, then number the Declination given upon the *Label* inwards, and where the numbring ends make a prick on your *Label*, then move the *Label* into the quarter where the Sun is, and lay the prick on the *Ecliptick* there, and your Triangle is made, wherein you may ſee the Longitude and Right Aſcenſion deſired. This needeth no Example.

Chap. VIII.

To find the Angle at the Sun, made between the Ecliptick *and* Meridian.

THis is the angle C of the former Triangle, and is the onely part which cannot be found in the former poſture of the

the Triangle, neither in chap. 6 nor 7, but is eaſily had by converſion of the Triangle, as you may remember out of the third Book.

Take the Triangle of chap. 6, and make the *Cathetus* Baſe, for this turn: and by the 1 or 2 Problemes of Rectangled Triangles, you may find this angle to be 77 degr. 43 min.

CHAP. IX.

To find the ſaid angle of the Ecliptick, *with the Meridian, by the Longitude, Declination, or Right Aſcenſion, divers other wayes.*

IN the Meridional Projection do thus.

If you have the Longitude given, count the diſtance of the Sun in that Longitude from the next Equinoctial point, and count ſo many degrees in the *Arctick* Circle from the *Limb* inwards: to the end of this numbring, lay the *Label*, and between the *Label* and Equator you have upon the *Limb* the leſſer angle made between the *Ecliptick* and Meridian; the greater angle is the ſupplement thereof. Alſo between the *Arctick* Circle and the *Limb* you may find the Declination on the *Label*, which is more then was required.

If you have the Declination given, count it on the *Label* inwards, and make a prick where the number ends, then turn this prick upon the *Arctick* Circle, and the *Label* ſheweth the leſſer angle in the *Limb*, as before.

Example. I would know what angle the Meridian that cutteth the Sun in ♉ 9 degr. maketh with the *Ecliptick*. I number therefore in the *Arctick* Circle from the *Limb* inwards 39 deg. and to the 39th degr. I lay the *Label*, and it ſheweth in the *Limb* the angle ſought 71 degr. 20 min. and in the *Label* the Declination of ♉ 9 degr. *viz.* 14.32 minutes: this is a good way. But that the *Label* at this 39th degr. cutteth the Pole of the Ecliptick (as Mr. *Blagrave* ſaith Book 3, 40.) is not true: either Mr. *Blagrave* or the Printer here miſtakes. For the Pole of the *Ecliptick* lies 14.24 minutes nearer the Axletree, as you ſhall find in the next rule.

2. Another way. Mark what is the Right Aſcenſion of the point propoſed, being counted from the next Equinoctial point (as of

♉ 9,

♉ 9 degr. the Right Aſcenſion is 36.36 min.) count ſo many degrees in the *Arctick* circle from the Axeltree: at the end of this number is the Pole of the *Ecliptick*. Lay the *Label* to him, and you ſhall make a Quadrantal Triangle, whoſe Sides ſhall be equal to the Angles of the former Triangle, which was made of the Longitude, Declination, and Right Aſcenſion, of the point propoſed: for the Right Angle you have a Radius or Quadrant of the Axis: for the Angle of the greateſt Declination between the Equator and *Ecliptick* $23\frac{1}{2}$, you have the arch of a Meridian between the Pole of the Equator and the Pole of the *Ecliptick*: for the angle ſought, you have the arch of the *Label*, between the Pole of the *Ecliptick* and the Center 71.20 minutes; as before: the leaſt angle of this Quadrantal Triangle is at the Center, and you ſhall find his meaſure in the *Limb* 14.32 minutes: that is the meaſure of the leaſt Side of the former Triangle, *viz.* the Declination of the point propoſed.

Here you ſee, If the Declination had been given, you ſhould have ſet it in the *Limb*, between the Pole and the *Label*, and ſo had you made the ſame Quadrantal Triangle, and might have found on the *Label* between the *Arctick* Circle and the Center the meaſure of the angle ſought: and likewiſe in the *Arctick* Circle between the *Label* and the Axtree-line the Right Aſcenſion, though it be more then was required. The reaſon hereof you may learn from Book 3. 7.

Chap. X.

To find the point of the Ecliptick *in which the Longitude and Right Aſcenſion have greateſt difference.*

MOve the *Label* on the Polar circle till you find the degrees of the *Label* between the Polar circle and the *Limb* to be equal to the degr. of the *Limb* between the *Label* and the Pole, ſo have you a Rectangled æquicrurall Triangle made by the *Limb*, *Label*, and the Meridian $46\frac{1}{4}$; like to that in the ſecond Variety, Book 3.10.

Here the angle B at the Pole between the $46\frac{1}{4}$ Meridian and the *Limb*, is equal to the Longitude of the point ſought $46\frac{1}{4}$, and either Leg is equal to the Declination thereof $16\frac{1}{4}$: Therefore I conclude, that when the Sun is $46\frac{1}{4}$ in Longitude. (that is in ♉ $16\frac{1}{4}$) then

then his Longitude hath furtheſt out run the Right Aſcenſion. Subtract now the Right Aſcenſion of ♌ 16 1/4, which is 43 3/4 out of the Longitude 46 1/4; there remains 2 deg. 1/2: which being converted into Time, is 10 min. the greateſt inequality of Aſcenſion in a Right Sphear.

CHAP. II.

To find the Latitude *of your Place, or the* Elevation *of the Pole above your* Horizon, *by the* Meridional Altitude, *and* Declination *of the* Sun. Meridional Projection.

GEographers call the diſtance of a place from the neareſt point of the Equator upon Earth, the *Latitude of that Place*, as the Latitude of London is 51 deg. 32 min. from the Equator Northward: the Latitude of S^t *Thomas Iſland* upon the coaſt of *Africk* is 0 deg. 0 min. becauſe the middle of that Iſland lyeth under the Equator. And becauſe the Latitude of your Place, and the Elevation of the Pole above your Horizon, are alwaies equal, therefore the Elevation of the Pole is oft called *Latitude of the Place*, or *Latitude* ſimply: and ſo for brevity ſake we ſhall often call it. But when we ſpeak of the Latitude of the Moon or Stars, you muſt underſtand Aſtronomers thereby mean their diſtance from the neereſt point of the Ecliptick.

To find the Latitude of your Place, get the Suns Declination, by the 6 or 7th. and his Meridian Altitude by the ſecond of this Book: Then find the parallel of the Suns Declination, North or South as the Declination is, and where it toucheth the *Limb* (here Meridian) there is the point where you obſerved the Sun at Noon; ſet the South end of the Finiter ſo many degr. below this point as the Meridian Altitude had, then is your Finiter ſet to your Latitude, and you ſhall find the meaſure of it between the Equator and the *Zenith*, (which is properly the Latitude) and the ſame meaſure ſhall you find between the North point of the Finiter and the North Pole, where it is more properly called the *Elevation of the Pole*.

Example. *June* 20 1651. I obſerved the Meridian Altitude of the Sun, here at *Eſton*, four miles Eaſtward from *Northampton*, 60 degr. 59 min. the Longitude of the Sun was then ♋ 8 degr. 19 min. 1/2, his Declination 23 degr. 14 min. Northward. There-

fore having found in the *Limb* the point where the Parallel 23 degr. 14 min. toucheth above the Equator, I put the South end of the Finiter 60 degr. 59 min. below that point, toward the South Pole, which done, I see the North Pole Elevated above the Finiter 52 degr. 15 min. and the *Zenith* of my Horizon likewise to be removed from the Equator Northward 52 degr. 15 min. which is the Latitude of *Eton*.

Note that you may best observe the Latitude when the Sun is near the *Summer Tropick*; for then you shall not be troubled with Refraction; and then the Declination varyeth slowly; which varyeth almost one minute every hour near the Equinoctial.

Chap. XII.

To do the same by the Meridian Altitudes of the Stars about the Poles.

MAny of the Stars near the Northern Pole may be seen with us twice in the Meridian in one Winters Night: that is, one while above the Pole, and 12 hours after again below the Pole. As for Example, the Pole-star, called *Alrucabe*, about *December* 18 will be in the Meridian above the Pole at 6 of the clock at Night, and at 6 next morning he will be in the Meridian below the Pole.

Observe both the Meridian Altitudes, and add them together, half that sum is the Elevation of the Pole. Example. I observed at *Eton* the greatest Altitude of the Pole-star to be 54 deg. 45 min. and his least Altitude 49 degr. 45 min. the sum is 104 deg. 30 min. the half 52 degr. 15 min. the Latitude of *Eton*: and here I have gotten also the Pole-stars distance from the Pole, and consequently his Declination which is the complement thereof, for the Latitude being subducted from the greater Altitude leaves the Stars distance from the Pole 2 degr. 30 min. and consequently shewes his Declination to be 87 degr. 30 min. which is 39 min. more then *Gemma Frisius* observed it, *Anno Dom.* 1547. for in our age the Pole-star approcheth about 1 min. nearer the Pole in every 3 years.

Note that these Stars which are distant from the Pole less then the Latitude, and more then the complement thereof, have their less

leſs Meridian Altitude in the North part of the Meridian, and their greater Meridian Altitude in the Southern part of the Meridian beyond the *Zenith*. Wherefore for them you ſhall take the complement of their greater Altitude, and add it to the North Quadrant of the Meridian, and if to that ſum you add the leſſer Altitude, the half thereof ſhall be your Latitude. But the nearer any Star is to the Pole, the fitter for this purpoſe, and therefore none better then *Alrucabe*, who is the neareſt of all.

CHAP. XIII.

To find the Declination of the Sun *or* Stars, *by their Meridian Altitude, and the* Elevation *of the* Pole.

THis is done by the firſt, made of the Meridional Projection, where having ſet your Finiter to the Elevation of the Pole, or your *Zenith* to the Latitude, (for as hath been ſhewed Chap. 11. all comes to one, and in doing either, you do both) and having obſerved the Meridian Altitude of the Sun or Star, number the Altitude obſerved upon the *Limb* of the *Reet* on the South or North ſide of the Pole, according as the Star was obſerved to be, and there ſhall meet you on the *Mater* his Parallel of Declination.

Example. I obſerved the Suns Meridian Altitude at *Elton*, 20 deg. I look therefore where the 20th *Almicanter* toucheth the *Limb*, (the Finiter firſt ſet to the Latitude) and there meets at the *Limb* the 17 $\frac{3}{4}$ Parallel below the Equator: wherefore I ſay, the Sun declineth 17 degr. 45 min. Southward. Again, I obſerved the Star *Alhaiot* in the North part of the Meridian 6 degr. 42 min high, I go to that *Almicanter* in the North quarter of the *Reet* under the Pole, and there meeteth at the *Limb* the Parallel 45 min. $\frac{1}{2}$ of North Declination.

CHAP. XIV.

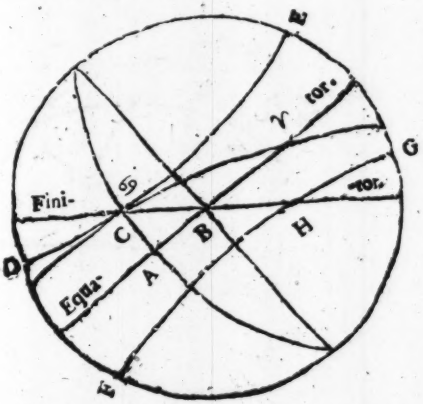
To find the Oblique Aſcenſion and Deſcenſion, and the Aſcenſional difference of the Sun or any Star: by his Declination, and the Latitude of the Place, Two ſeveral wayes, in the Horizontal Triangle.

THE Oblique Aſcenſion is the arch of the Equator which riſeth with the Sun or any Star in an Oblique Sphear, that is, a Sphear wherein the Equator maketh an Oblique Angle with the Horizon. This arch beginneth alwayes from the Vernal Equinox, but we ſeek the latter term or end thereof. To find this by Calculation, we uſe to find firſt the Aſcenſional difference, that is the difference of the Right and Oblique Aſcenſion, or the arch of the Equator comprehended between the latter termes of the arches of the Right Aſcenſion and Oblique Aſcenſion of the *Star*, this difference for North *Stars*, we ſubtract from the Right Aſcenſion, and the remainder is the Oblique Aſcenſion; but for *South Stars* we add it to the Right Aſcenſion to make the Oblique Aſcenſion: and for Oblique Deſcenſion or Setting, contrarily, we add the Aſcenſional difference for North *Stars*, and ſubtract it for *South*: you ſhall ſee all plain in the Meridional Projection of the Planiſphear, and the firſt Mode thereof, where the Finiter is ſet to the Latitude.

Example. I would know the Oblique Aſcenſion of the *Sun* in ♋ 0 and the Aſcenſional difference. The Declination of the *Sun* in ♋ 0 is 23 degr. 30 min. our Latitude 52 degr. 15 min. I go to the North Parallel 23 degr. $\frac{1}{2}$, which is the *Tropick* of Cancer, on the *Mater*, and following him to the Finiter, there I turn in the Meridian which cutteth there, and go down to the Equator under the Horizon, and make a prick here; I ſay, is the Right Aſcenſion of the *Sun* in Cancer ♋, for the ſame Meridian cutteth both theſe, and therefore both theſe points would riſe at once in a Right *Sphear*, where the Meridians by turns ſucceſſively, become Horizon: but counting how many degrees are between this prick and the riſing point of the Equator, I find 34 degr. 10 min. this is the arch of Aſcenſional difference, which being ſubtracted out of the Right Aſcenſion of ♋ 0 (which by Chap. 6 is 90 degr.) there remaineth the Oblique Aſcenſion 55 degr.

degr. 50 min. And the meaning is, that whereas the Sun being in ♋ 0 in a Right Sphear, riſeth with the 90th degree of the Equator, in our Latitude, he riſeth with the 55 degr. 50 min. of the Equator: the difference of theſe Aſcenſions is 34 degr. 10 min. add this difference to the Right Aſcenſion of ♋ 0, and it maketh 124 degr. 10 min. the Oblique Deſcenſion, for the 124th degree of the Equator ſetteth with ♋0, and the point of the Suns Right Aſcenſion ſhall in North Signes Set before him as much as it Riſeth after him, and in South Signes ſhall Set after him, as much as it Riſeth before him. This you may ſee plainly by the view of this Projection; if you imagine it one while to be the Eaſtern *Hemiſphear*, and another while the Weſtern *Hemiſphear*, at your pleaſure.

The Horizontal *Triangle.*

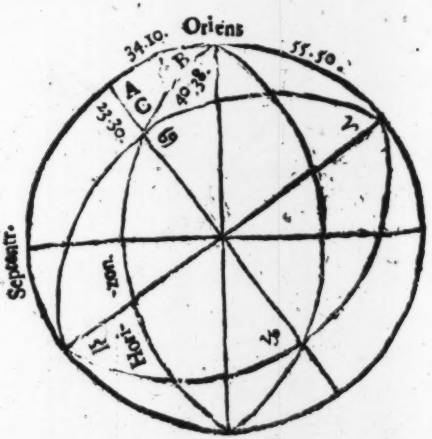


Take in the Scheme of the Horizontal Triangle annexed, ſo many Circles of your *Planiſphear* as you ſhall uſe for this purpoſe, and moreover ſee here how the *Ecliptick* ſhould lie in your *Planiſphear* when ♋ 0 is riſing, which the *Planiſphear* in this poſture cannot expreſs.

♈ ♋	Is the arch of the Suns Longitude	90 degr.
♈ A	Is the arch of the Suns Right Aſcenſion	90 degr.
♈ B	Is the arch of the Oblique Aſcenſion	55 degr. 50 min.
B A	Is the Aſcenſional difference	34 degr. 10 min.
A B C,	I cal the *Horizontal* Triangle.	

The ſame way ſerveth for the Stars, for the Stars Parallel of Declination followed to the Finiter, ſhall bring you to C of the Triangle, as the Suns did, and then you know what to do.

A ſecond way and more eaſie and pleaſant, is by the Equinoctial Projection. Place the Sun or Star upon the Eaſt part of your Horizon, (in the North-eaſt quarter, if the Declination be North; but in the South-eaſt quarter, if the Declination be South; as you had direction, Book 2, 2.) and the degrees of the *Limb* by which ♈ o is gone paſt *Oriens*, or the ſix a clock line of the *Mater*, are the degrees of Oblique Aſcenſion, ſubduct this out of the Right Aſcenſion, if the Star be North, or out of this ſubduct the Right Aſcenſion, if the Star be South, and the remainder is the Aſcenſional difference. But this ſubduction is made to your hand in the *Planiſphear*.



Take the former Example. The Latitude here is 52 degr. 15 min. the Suns Declination in ♋ 0, is 23 degr. 30 min. as before. Now See in this ſecond figure of the Horizontal Triangle A B C, how the Circles lie in the *Planiſphear*, ſet ♋0 on the North-eaſt part of the Horizon at C, and you have before your eyes.

♈ ♋ the Suns Longitude.	90 degr.
♈ A the Suns Right Aſcenſion.	90 degr.
♈ B the Suns Oblique Aſcenſion.	55 degr. 50 min.
B A the Aſcenſional difference.	34 degr. 10 min.

CHAP.

Chap. XV.

The Aſcenſional difference, Declination, and Amplitude, of the Sun or a Star, and the Latitude of the Place, any two of them given, to find the reſt.

The Amplitude or Ortive Latitude is the arch of the Horizon between the riſing-point of a *Star* and the full Eaſt point. This is the *Hypotenuſa* of the Horizontal Triangle, expreſſed in both the *Schemes* of the former Chapt. Now I told you Book 3. 2. that if any two parts of a Rectangled Triangle be given with the Right angle, the reſt may be eaſily found; obſerve then your Triangle A B C in the firſt *Scheme* of the former Chapter, and likewiſe in the Meridional Projection of your *Planiſphere*, you ſhall ſee the very ſame. For the Finitor being ſet to the Latitude, C ſhall be where the *Tropick* of Cancer cuts the Finiter: the arch of the Meridian between C and the Equator is C A and the Declination: thence in the Equator to the center is A B the Baſe, and the Aſcenſional Difference B C in the Horizon is the Amplitude; B is the complement of Latitude; A is 90 degr. C is unknown, and we need it not, elſe, if you have read the third Book, I hope you can find him.

Here are ſix Caſes.

1. Admit now that the Declination and Amplitude be given, put the term of the Amplitude (I mean the point where it ends, counting from the Center) upon the Parallel of the Declination, and your Triangle is formed, and thereby the Aſcenſional difference and the complement of Latitude are diſcovered.

2. Or if the Declination and Aſcenſional difference be given, number the Aſcenſional difference from the Center downwards in the Equator: Then go up in a Meridian as many degrees as the Declination comes to, and to the point where you end (which is C) ſet the Finiter, ſo he is placed to your Latitude, and the Amplitude alſo is ſhewn.

3. Or if the Declination and Latitude be given, the Finiter being ſet to the Latitude, follow the Parallel of Declination to the Finiter

Finiter there is C, thence go down by a Meridian to A in the Equator, thence in the Equator to B at the Center, thence turn by the Finiter to C, and you have compaſſed your Triangle, and therefore have all known but C.

4. If the Latitude and Aſcenſional difference be given, the Finiter being ſet to the Latitude, count from the Center in the Equator to the end of the Aſcenſional difference, there is A: Go up thence in a Meridian to the Finiter; there is C: Go thence in the Finiter to the Center: there is B.

5. If the Latitude and Amplitude be given, the Finiter being ſet to the Latitude, count from the Center (B) in the Finiter to the end of the Amplitude (where ſhall be C) go down thence in a Meridian to the Equator, (where is A) thence in the Equator return to the Center B.

6. If the Amplitude and Aſcenſional difference be given, prick the end of the Amplitude numbred in the Finiter from the Center, and prick the end of the Aſcenſional difference, numbred in the Equator from the Center: then turn about the *Reet* till ſome one of the Meridians cut both theſe pricks, and that ſhall make up the Triangle.

Note, that for South Stars, or the Sun in *South Signes*, this Triangle lies on the South-ſide the center, and above the Finiter; but for North Signes it lies North of the center, and below the Finiter.

Chap. XVI.

To do the ſame in the Equinoctial Projection.

Here ſerves the ſecond figure of the Horizontal Triangle in Chap. 14. where B A is the Aſcenſional difference; C A the Declination, B C the Amplitude, B complement of the Latitude.

If the Latitude and Declination be given, number the Declination on the *Label* inwards, and at the end make a prick, turn this prick to the Horizon of the *Mater*, and ſo ſhall the outward arch of the *Label*, be C A, the ſhorter arch of that Horizon B C, and an arch of the *Limb* B A of your Triangle.

If the Latitude and Amplitude be given, do as in this Example. I obſerved *Sirius* to riſe 27 $\frac{1}{4}$ from the Eaſt South-ward my

my Latitude is 52 degr. $\frac{1}{4}$. I go to the 52 $\frac{1}{4}$ Meridian on the *Mater*, reckoned from the Center on the South-ſide, becauſe the *Star* is *Southern*, as his riſing ſhewes. This 52 $\frac{1}{4}$ Meridian being my Horizon (as Book 2.2.) I number in him the Amplitude of *Sirius*, from *Oriens* toward *Meridies* 27 $\frac{1}{4}$, and thereto I lay the *Label*; and I ſee my Horizon cuts the *Label* in 16 $\frac{1}{4}$, that is C A the *South* Declination of *Sirius*: and between the *Label* and *Oriens* in the *Limb*, I have B A 22 $\frac{1}{4}$, his Aſcenſional difference. If you can do theſe two, you may reſolve the four other Caſes of this Chapter with like facility. View but the *Scheam* in the Book, and in your Planiſphear, and that alone will inſtruct you.

CHAP. XVII.

To find the Semi-diurnal *and* Semi-nocturnal *Arches of the* Sun *or* Stars: *the time of their Riſing and Setting: and the length of their Day and Night: by Declination, and the Latitude of the Place.*

SEt the Finiter to the Latitude, (as in the firſt Mode of the Meridional Projection.) Then ſeek the Parallel of the Declination of the *Sun* or *Star*, North, or *South*, as it hapneth to be. That Parallel ſhall be divided by the Finiter into two arches: the arch above the Finiter is the *Semi-diurnal* arch, in which you may count the time of Riſing and Setting, and the Length of the Day: that below is the *Semi-nocturnal* arch, in which you may reckon the length of the Night; or if your Queſtion be of a Star, the time he ſpends under the Horizon.

Example. In the firſt Scheme of the 14th Chapter, D E is the *Tropick* of *Cancer*, that is the 23 $\frac{1}{2}$ Parallel of North Declination: C E is the *Semi-diurnal* arch: C D the *Semi-nocturnal*. And you ſhall find in the Meridional Projection of your Planiſphear thoſe arches are divided by the Meridians; and the arch C E containeth 124 degr. 10 min. which turned into houres and minutes, (accounting every degree 4 minutes of Time, and every 15 degrees an houre,) is 8 houres 16 min. 40 ſec. half the length of our longeſt Day, and the arch C D containeth 55 deg. 50 min. that is, three houres 43 min. 20 ſec. half the length of our ſhort-

eſt Night: therefore at three hours 43 min. after midnight the Sun Riſeth in the *Tropick*, and ſets ſo much before midnight, that is, at eight hours 16 min. 40 ſec. and ſo may you find your deſire in any other Parallel.

Example. 2. I obſerve that *Fomahant* his Meridian Altitude is but 6. 30 min. therefore by Chap. 13 he declineth Southward $31\frac{1}{4}$. I would know how long he ſhines with us; and I preſently ſee in the Meridional Projection of my Planiſphear, that his Parallel hath but 38 degr. above the Horizon; that is, he will ſet two hours 32 min. after he is South; and the whole time he ſhines in our Horizon, is five hours four minutes.

Example. 3. *Lyra* her Declination is 38. 30 min. North; and I ſee his Parallel comes within 45 min. of the Horizon, in the North part of the Meridian, but never toucheth it: therefore I conclude that *Lyra* never ſets with us at all.

Chap. XVIII.

To find the ſame, in the Equinoctial Projection.

TUrn about the *Reet* till the Suns place in the *Ecliptick*, or the point of the Star, touch your proper Horizon: and that on the North ſide, if the Declination be North, or on the South ſide, if it be South. Lay the *Label* to the Sun or Star in the Horizon, and between the *Label* and *Meridies* upon the *Limb* you ſhall have the *Semi-diurnal* arch, both in degrees, and in hours and minutes. And you ſhall obſerve that thoſe Stars whoſe Declination is greater then the complement of your Latitude (as *Lyra*'s was in the laſt Chap.) will never touch the Horizon at all. For Stars of ſuch Declination, if they be North, never ſet; and if they be South, never riſe at our Town.

But what ſhall I do if the Star be not in my *Reet*? Then will I number his Right Aſcenſion on the *Limb* of the *Reet*, and having thereto laid the *Label*, I will number his Declination upon the *Label* from the *Limb* inwards, and where it ends make a prick by the edge of the *Label*, in the *Reet*, for him: for there is the place of the Sta: but if the Stars place happen to be in a window of the *Reet*, where the *Reet* is perforated, then I will make the prick upon the *Labels* edge at the Stars Declination, and

and turn that prick to the Horizon. I may pinch the *Label* close with the *Reet*, and turn both together, which willbe the handsomer way, but if I move the *Labels* prick alone to the Horizon, it is sufficient for this Probleme, which needeth no more words.

Chap. XIX.

To find the beginning and end of Twilight, *by the* Suns Declination, *and the* Latitude *of the Place.*

Set the Planisphear in the first Mode of the Meridional Projection; then turn the Planisphear that the *Zenith* may be downwards, and the *Almicanters* mostly below the Horizon. Then go to the 18th *Almicanter* below the Horizon: and whereſoever the Parallel of the Suns Declination doth cut that *Almicanter*, there is the beginning and end of Twilight: and becauſe every Parallel is divided by the Meridians into 12 hours, or 180 degr. (every 15 degr. being one hour) therefore you may eaſily count how far the point where Twilight begins, is diſtant from Midnight, or from Noon, or from Sun-riſe, or Sun-ſet in the Horizon.

Example. In our Latitude 52 degr. 15 min. my Planiſphear ſet as aforeſaid, I find that where the 18th *Almicanter* cutteth the Equator under the Horizon, there cutteth alſo in the ſame interſection the 30th Meridian, or ſecond Hour Circle from the Axis and Center; by which I gather, that when the Sun is in the Equator, the twilight begins two hours before 6 or Sun-riſing, and ends likewiſe at 8 of the clock at Night, the Sun then ſetting, (as you may ſee) at 6. Likewiſe where the Winter *Tropick* cuts the 18th *Almicanter*, there cuts alſo the firſt Meridian from the Axis South-ward; ſhewing that in the depth of Winter Twilight begins 4 minutes after 6 in the morning, and laſteth till 5 hours 56 minutes after-noon. Likewiſe I ſee that about the beginning of ♊ where the Sun declineth North-wards about 20 degrees, the Twilight laſts till mid-night, and that from that time till the Sun comes to ♌ (that is, from *May* 11 to *July* 11, or thereabouts,) we have no dark night at all, unleſs the Skie be Cloudy, for in all that time the Sun is never found above 18 degrees under the Horizon.

Chap. XX.

To find the time of the Cosmical *Rising and Setting of the Stars, by their Declination and* Right *Ascension, and the Latitude of the Place.*

A Star is said to rise *Cosmically* when he riseth at the same instant with the Sun.

To find it, use the Equinoctial Projection: Turn the *Star* (being found in your *Reet*) to the East part of your Horizon, and look what degree of the *Ecliptick* cutteth the same East part of your Horizon; for when the *Sun* comes to that degree, the *Star* and *Sun* shall rise both together. If the Star be not in your *Reet*, put him in with ink, as you put in the rest, Book 1. 7. if his place light upon a window, or hole of the *Reet*, prick him on the edge of the *Label*, and hold *Reet* and *Label* close together, while you turn him to the Horizon.

Example. *Sirius* I have among 40 other principal *Stars* in my *Reet*, and would advise you not to be without him, for he is a little *Sun* in a Winters Night, to tell you how the time passeth; he is called by the *Latines* both *Canis*, and *Canicula*; for they had no name for the little *Dog*, but called him by the Greek name *Procyon*, as *Pliny* witnesseth *Lib.* 18 *Chap.* 28: yet I have seen a late Writer, who takes upon him to teach the *Colledge* of *Physitians* both *Physick* and *Astrologie*, before he hath well learned either of them: who in his Obtrectations upon the *Pharmacopea Lond.* in the Chapter of *Vinum Scilliticum Galeni*, betrayes his ignorance herein, as elsewhere in 100 other things, which I could shew; for in that very Chapter pag. 147 of his fourth Impression, in 24 short lines he commits 5 absurd errors. 1. He makes it doubtfull whether *Canis* be to be taken for *Sirius*, or *Procyon*. 2. He goeth about to teach *Galen* where *Squills* grow; and that there is no hilly ground near the Sea. 3. He supposeth that the *Acronycal* rising of the *Dog* (which hapneth in the depth of Winter) is a fitter time to gather *Squils*, then the *Heliacal* rising, which hapneth near unto the *Cosmical*, in the heat of Summer. 4. He either supposeth that *Squils* grow in the Parallel of *London*, or that by the rising of the *Dog* at *London* men should gather *Squils* in *Greece* or *Spain*.

5. He

5. He tells the *Colledge* that both the *Dogs* are between the Equator and the South Pole, which indeed is newes, if it were true. Let the ingenuous Reader pardon this digreſſion, and I proceed.

This *Sirius* I brought to our Horizon, (the 52 $\frac{1}{4}$) and found that there riſeth with him in the *Ecliptick* ♌ 18 $\frac{1}{2}$: in like manner, with *Procyon* riſeth ♌ 6 $\frac{1}{3}$: therefore *Sirius* riſeth *Coſmically* with us *Auguſt* 1: and *Procyon* 12 dayes ſooner. But in *Greece* and *Spain*, in the Latitude 38 degr. *Sirius* riſeth with ♌ 4 $\frac{1}{2}$, that is a fortnight ſooner.

A Star is ſaid to Set *Coſmically*, when the Sun riſeth at his ſetting. Place the Star therefore on the Weſt part of your Horizon: then look what degree of the *Ecliptique* riſeth in the Eaſt part; for when the Sun comes to that degree, the Star ſhall ſet *Coſmically*.

Example. I brought *Sirius* to the South-weſt part of our Horizon, where he uſeth to ſet. And in the South-eaſt part I ſaw ♏ 23 degrees in the *Ecliptique* riſing: therefore when the Sun is in ♏ 23. (which is about *November*, 5. then ſhall *Sirius* ſet *Coſmically*. But at *Athens* in Lat. 37 $\frac{1}{4}$.

His *Coſmicall* { Riſing is ☉ in ♌ 4. *July* 17 / Setting is ☉ in ♐ 9. *Nov.* 20

The *Pleiades* in our Lat *Coſmically* { Riſe ☉ in ♉ 12 $\frac{1}{8}$ *Apr.* 22. / Set ☉ in ♏ 29 $\frac{1}{2}$ *Nov.* 11.

At *Athens Coſmically*. { Riſe ☉ in ♉ 19 $\frac{1}{2}$ *April* 30. / Set ☉ in ♏ 27 $\frac{1}{2}$ *Novem.* 9.

Arcturus in our Lat. *Coſmically*. { Ri. ☉ in ♎ 0 *Sep.* 13. / Set. ☉ in ♋ 4 *June* 15.

At *Athens Coſmically*. { Riſe ☉ in ♎ 10 $\frac{1}{2}$ *Sept.* 23. / Set ☉ in ♊ 6. *May* 17.

CHAP. XXI.

To find the time when any Star riſeth or ſetteth Acronycally, *by his Declination, and Right Aſcenſion, and the Latitude of the Place.*

WHen a Star Riſeth juſt at Sun-ſetting, he is ſaid to riſe *Acronically*. To find the time, turn the Star to the Eaſt part of the Horizon in the Equinoctial Pro-

jection, and mark what degree of the Ecliptique deſcendeth in the Weſt: for when the Sun comes to that degree, the *Star* ſhall riſe *Acronically*.

Example. When *Sirius* toucheth the *South* East Quartet of our Horizon, I ſee ♒ 18. ſetting. Therefore when the *Sun* is in ♒ 18. *Sirius* riſeth *Acronically*.

A *Star* ſetteth *Acronically*, when he ſetteth with the *Sun*. To find the time, place the *Star* ſetting, in the Weſt-part of the Horizon, and ſee what degree of the Ecliptique ſetteth with him: for when the *Sun* is in that degree, the *Star* ſhall ſet *Acronically*. Thus in our Latitude.

Sirius Acronically. { Riſeth ☉ in ♒ 18. *Jan.* 27. / Seteth ☉ in ♉ 23. *May* 3.

At *Athens Sirius Acronically.* { Ri. ☉ in ♒ 4. *Jann.* 13. / Set. ☉ in ♊ 9. *May* 20.

Pleiades Acronically. { Riſeth ☉ in ♏ 13. *Octo.* 26. / Seteth ☉ in ♉ 29½ *May* 10.

At *Athens Pleiades Acroni.* { Riſeth ☉ in ♏ 19½ *Nov.* 1. / Seteth ☉ in ♉ 27½ *May* 8.

Arcturus Acronically. { Riſeth ☉ in ♈ 0. *March* 10. / Seteth ☉ in ♑ 4 *Dec.* 15.

At *Athens Arcturus Acroni.* { Riſeth ☉ in ♈ 10.½ *Mar.* 20. / Seteth ☉ in ♐ 6. *Nove.* 18.

Chap. XXII.

To find when a Star riſeth or ſetteth Heliacally.

A *Star* riſeth *Heliacally* when he geteth out of the beames of the *Sun*, and beginneth to be ſeen in the East a little before *Sun* riſe. And a Star is ſaid to ſet *Heliacally* when he getteth into the beams of the *Sun*, and beginneth to be leaſt in the evening by reaſon of the *Suns* approach to him. Thoſe Stars which you ſee neareſt the East Horizon in the Morning Twilight are *Heliacall* Riſers; and thoſe which you ſee neareſt the Weſt part of the Horizon, in the evening Twilight are *Heliacall Setters*. For this no exact rule can be given, for all men have not like quickneſs of ſight, nor all Stars like brightneſs, nor all Climates, Countries and Dayes of the Year the ſame clearneſs of Air. And the Moon oft times augment

menteth the Twilight, when she is within a few dayes of the Change, and keepeth the *Stars* longer Combust. Commonly about twenty dayes before their *Acronicall* setting they come within the *Sun* beames, and so set *Heliacally*, and they appear again, (that is, rise *Heliacally*) about twenty dayes after their *Cosmicall* rising. But if they be great *Stars*, the Air clear, your sight good, the angle made between the *Ecliptique* and the Horizon great, they may appear sooner: and later in the contrary Cases. According to this rule the *Pleiades* set *Heliacally*, now at *Athens* ☉ in ♉ 7. and rise *Heliacally* ☉ in ♊ 9. so they should be Combust there 32 dayes; but because they be *Stars* of less Magnitude, we may perhaps allow them 40 dayes as *Hesiod* did in his time, in the beginning of his Second book of Weeks and Dayes. Αἳ δή τοι νύκτας τε καὶ ἤματα τεσσαράκοντα κεκρύφαται.

Chap. XXIII.

To find the Age when any Astrologer *lived, and what time of the* Solar *year the Seasons hapned in his Country, by knowing his Latitude, and the Rising of any Star in his time.*

THe old *Grecians*, and after them the *Latines*, before *Julius Cæsar* especially, designed the *Seasons* of the Year by the rising and setting of some notable Stars. *Hesiod* begins his second book of Weeks and Dayes: with this *Georgical Canon*.

Πληϊάδων Ἀτλαγενέων ἐπιτελλομενάων
Ἄρχεσθ' ἀμητοῦ, ἀρότοιο δὲ δυσομενάων. That is, when the *Pleiades* rise, begin to Mow, and to Plow when they set; And in the same Book *Vers.* 182. he saith

Εὖτ' ἂν δ' ἑξήκοντα μετὰ τροπὰς ἠελίοιο
Χειμέρι' ἐκτελέσῃ Ζεὺς ἤματα, δή ῥα τότ' ἀστὴρ
Ἀρκτοῦρος, προλιπὼν ἱερὸν ῥόον Ὠκεανοῖο
Πρῶτον παμφαίνων, ἀνατέλλεται ἀκροκνέφαιος.
Τὸν δὲ μετ' ὀρθογόη Πανδιονὶς ὦρτο χελιδὼν
Ἐς φάος ἀνθρώποις, ἔαρος νέον ἱσταμένοιο. That is, 60 dayes after the Winter *Tropique Arcturus* riseth *Acronically*, and then appears the Swallow, the Spring being then new begun.

These and the like rules were the Husband-mans Almanack,

by

by which they measured the Solar Year, and the return of the Seasons. For in their Civill Year, consisting of Lunar Moneths, by reason of an intercalary Moneth which was added every third Year, and somewhat ofter, the Seasons could not happen upon the same day of the moneth yearly, but sometimes 2 or 3 weeks sooner or later, as our moveable Feasts do. The rising and setting of the fixed Stars keep the same distance Yearly, from the Equinoctial and Solstitiall points, for a mans age near enough; but longer those rules cannot last without some perceivable error: for in 100. years the Stars go forward in Longitude, according to *Tycho*, 1 degree 25 minutes, by reason whereof the risings and settings of the Stars happen later in the Year, about a day and half every 100 years in the same Latitude.

Now if you would note in what Age a Star had such a rising or setting, in such a Latitude, as for Example. In what age *Arcturus* rose 60 dayes after mid-winter in the Latitude of *Asera* in *Bœotia* near *Athens*, whose Latitude is 37 $\frac{1}{4}$, and consequently how long since *Hesiod* lived, in whose dayes *Arcturus* had such rising, you shall reason thus: 60. dayes after the Winter *Tropick* the Sun is in ♓ 1 degree by the *Ephemeris* for in those 60 dayes near his *Perigium* he goeth about 61 degrees. I am therefore to seek when *Arcturus* did rise at *Athens* with the opposite degree of the *Ecliptique*, ♍ 1 degree (the Sun is in ♓ 1 degree, then setting over against it.) I seek the Longitude and Latitude of *Arcturus*, and find in *Tycho's* Tables that *Anno Domi.* 1600. *Arcturus* had Longitude ♎ 18. 39 minutes, Latitude B. 31. 02. minutes: then I will suppose that *Hesiod* lived 830. years before Christ (for there some *Chronologers* place him, but without any good proof that I find) that is, 2430 years before *Anno Domi.* 1600. in which space of time *Arcturus* must have increased his Longitude by *Tycho's Hypothesis* 34 degrees 25 minutes, which being subducted out of the Longitude which *Arcturus* had *Anno Domi.* 1600. leaves his Longitude for the year before Christ 830. ♍ 14. degree 14. minutes, his Latitude was then and ever 31. 02 minutes. Now from this Longitude and Latitude, I get his Right Ascension, and Declination, by Chap. 34. of this Book, where I find Ascension 180. degrees, Declination North 34. degrees 15 minutes: those had, I place *Arcturus* in my *Reet* according to that Right Ascension and Declination (as was taught Book 1 7. and Book 4. 18.)

18.) and by Chapter 21. I find ♏ 4 riſing with him; and at the ſame time ♐ 4. ſetting in the ſame Horizon of *Athens*. But I ought to find ♐ 1 degree ſetting in *Heſiods* time. Therefore I will ſuppoſe again that *Heſiod* lived 1120 years before Chriſt: and proceeding as upon the former ſuppoſition, I find that then ♏ 29. degrees did ſet at his *Acronical* riſing: but I ought to find ♐ 1 degree riſing. And ſeeing it is hereby found, that in 300 years his *Acronicall* ſetting varies 5. degrees, or dayes; I take the proportional part of that time, and ſay that in the year 1010. before Chriſt, *Arcturus* did ſet *Acronically* 60. dayes after the Winter *Tropique*: and then lived *Heſiod*, or ſoon after. For being an *Aſtrologer* himſelf (as *Pliny* tells us *Lib.* 18. 25. ſaying, *Hunc quoq; nomine extat Aſtrologia*,) it is likely he would not uſe an antiquated rule. *Arcturus* therefore roſe *Acronically* at *Athens* in *Heſiods* time, ☉ in ♐ 1 degree, that is, about *Febr.* 9. of our *Julian* year, as it now goeth: then the Swallow uſed to come to *Athens*: but in our Age he riſeth *Acronically* at *Athens* ☉ in ♈ 10½ that is, *Mar.* 20. and at *Eſton* or *Northampton*, ☉ ♈ 0. that is, *Mar.* 10.

By this you may ſee that the old Aſtrological Rules concerning the riſing and ſetting of the *Stars*, left us by *Heſiod*, *Cato*, *Aratus*, *Varro*, *Palladius*, *Virgil*, *Ovid*, *Pliny*, *Columella*, *Ptolomy*, and other Ancient Authors cannot ſerve for our Age, nor for every Latitude; and the beſt uſe we can make of them, is to find the Age when they lived.

Pliny, *Lib.* 18. 26. ſaith, that in *Cæſars Calender octavo Calend. Martij* was *Hirundinis adventus & poſtero die Arcturi exortus Veſpertinus*. Which agrees not to *Cæſars* time.

Alſo *Lib.* 2. 47. he ſaith, *Ardentiſſimo æſtatis tempore exoritur Canicula ſidus Sole primens partem Leonis ingrediente, qui dies eſt 15. ante Calend. Auguſti* (that is, *July* 18,) *Rome* is in Latitude 42. degrees, *Pliny* lived about 70. years after Chriſt; then was *Canicula* (that is *Sirius*) in ♊ 17. degrees Latitude, 39 ⅓ Right Aſcenſion, 79 ½ Declination, South, 16 ⅔, and did riſe at *Rome Coſmically*, *decimo quinto Calend. Auguſti*, or *July* 18. as thus far he reports truly: but the Sun was not then in ♌ 1 deg. as *Pliny* ſaith but in ♋ 23 degrees: for the Sun entred ♌ in his time not *decimo quinto Calend. Auguſti*, but *octavo Calend. Auguſti*. The Sun in thoſe dayes entring the ſeveral Signes moſtly on the 5 day of the ſeveral moneths, as in our Age a-

bout the 11th day, as *Aſtronomers* well know. *Pliny* ſeemes to have taken his *Aſtrologie* upon truſt. And I cannot deviſe what ſhould lead him to ſuppoſe, that howſoever the *Equinoxes* and *Solſtices* in his time hapned *octavo Calend.* (as he denyeth not) yet the Sun entred into a new Signe about the Ides of every Moneth, and that the Equinoctial and Solſtitial points were in *Octavis partibus ſignorum*, as if the Sun came not to the Equinoctial till he came to the 8th degree of *Aries*. See *Pliny* Book 18. Chapter 25, 26, 27, 28. He ſeemeth to diſtrust the *Julian Calender*, and to adhear more to the account uſed by *Varro de Reruſticâ Lib.* 1. 27. but either he underſtood neither of them well, or I do not well underſtand him.

Now *Sirius* riſeth in our Horizon with ♌ $18\frac{1}{2}$, about *Auguſt* 1, in the Declination of the heat, who in *Plinyes* time roſe *ardentiſſimo æſtatis tempore*. And our Dog-dayes if we follow the Dogs riſing, will be every age colder and colder, and at length fall in Winter. It were better to reduce them to the Suns entrance into *Leo*, or to *Cancer*, 23, rather as they were in *Plinyes* time: and to count the *ardentiſſimum tempus* a fortnight before and a fortnight after: for *Sirius* was not by the Ancients ſuppoſed the cauſe of the ſultry heat of Summer, but a concomitant ſigne of that Seaſon, whereof the Suns continuance in the North-Signes was the cauſe.

Would you know alſo when they began to Plow and to Mow in *Greece* in *Heſiods* Time? He ſaith, when the *Pleiades* riſe, begin to Mow, and to Plow when they ſet. The *Pleiades* (I mean the brighteſt of them) 1010. years before Chriſt, were in ♈ 17. 25. minutes, Latitude 4 degrees North. Declination therefore by Chapter 34) 11 degrees, Right Aſcenſion $14\frac{1}{2}$ degrees; therefore they roſe *Coſmically* at *Athens* or *Aſcra*, (*Heſiods* birth Place) ☉ in ♈ $10\frac{1}{3}$, that is, as our *Julian* year now goeth, about *March* 20. The *Heliacall* riſing is about 20. dayes after the *Coſmicall* (Chapter 22.) that is about *April* 9. Therefore either *March* 20. at the *Coſmical* riſing, or *April* 9. at the *Heliacall* riſing, they began to Mow, and I think he means the *Coſmicall*; the *Acronicall* riſing was there in his Age ☉ in ♎ $10\frac{1}{3}$ about *Sep.* 23. which is too late beyond reaſon. Now that they ſhould begin Mowing in *Greece* within 10. dayes after the Equinoctial is not ſtrange, ſeeing the firſt fruits of ripe Corn were offered at *Jeruſalem* yearly at *Eaſter*; which fell ordinarily 15. dayes

dayes after the Equinoctial, or thereabout. *Duet.* 16. And in *Egypt - cum falce arva visunt Paulo ante Calendas Apriles, messis autem peragitur Maio*, saith *Pliny* 18. 18. *viz.* Harvest began in *Egypt* a little before *April*, and *April* then began 8. dayes after the Equinoctial onely.

The *Cosmicall* setting of the *Plaiades* at *Athens*, in *Hesiods* time 1010. years before Christ was ☉ in ♎ 18. degrees *Octob.* 1. then began they to Plow and Sow: the *Egyptians* began *Novembri mense incipiente Pliny* 18. 18. But if *Hesiod* were now alive at *Ascra* he would find the *Plaiades* rise *Cosmically*, with ♉ $19\frac{1}{2}$ *April* 30. and set *Cosmically* ☉ in ♏ $27\frac{1}{2}$ *Nov.* 9. so much are his *Georgique* rules now antiquated, and serve for little else but to shew how many Ages ago he lived; and how the Seasons hapned in his Age.

CHAP. XXIV.

The Latitude *of your Place, the* Declination, Altitude, Azimuth, *and* Hour *of the* Sun *or* Stars, *any three of these being given, so find the other two.*

SEt your Planisphear in the first Mode of the Meridional Projection, and you shall find all these five in one Oblique-angled Triangle; which I use to call the Complemental Triangle; because it consists of three Sides, which are all Complements. (Others may call it as they please.) *The Complemental Triangle.*

A B in the *Limb* between the Pole and *Zenith*, Complement of Latitude.

A C in a Meridian, Complement of the Declination, or the Supplement of that Complement.

B C in an *Azimuth*, Complement of the Altitude.

A at the Pole is the Angle of *Horary* distance from the Meridian, whose full measure is in the Equinoctial line; but because every Parallel is divided by the Meridians into 180. degrees, as the Equator is, and every 5th. and 15th. Meridian plainly distinguished from the rest in the *Fabrique* of this Instrument, therefore you may easily count the angle of the Hour in any Parallel.

B at the *Zenith*, is the angle of the *Azimuth*, accounted from the North part of the Meridian: his full measure is in the Finiter-line of the *Reet*; but you may number it in any *Almicanter* be-

cauſe every 5th. and 15th. *Azimuths* are diſtinguiſhed on the *Reet*, as the Meridians are on the *Mater*.

C the place of the Sun or Star, in the meeting of the Meridian and *Azimuth*, is the third angle, which commonly is neither known nor enquired; but it may be found when you pleaſe, by turning the Triangle, as hath been often ſhewed.

Now if you be verſed in the 8 laſt Chapters of the third Book, you may eaſily find any of the requiſites of this Chapter without any more direction. Nevertheleſs for the Learners ſake, I ſhall exemplifie this general Probleme, in the 4 next Chapters, and alſo further in the 31, 32, and 33. Chapters hereafter following. See the Scheam Chap. 26.

Chap. XXV.

To find the Altitude *and* Azimuth *of the Sun or Stars, at any time propoſed; the Latitude and Declination being known.*

YOur Plasiſphear ſet in the firſt Mode of the Meridional Projection, as in the former Chapter, go to the Parallel of the Declination of the Sun or Star, and follow him through all the Meridians from the *Finiter* to the *Limb*; (which is the Meridian of your Place;) and thence back again to the *Finiter*, and you ſhall find at the firſt ſight what *Almicanter* and *Azimuth* croſs the Parallel in any point propoſed: and ſo have you the Altitude and *Azimuth* thereof.

Example. *June* 10 the Sun was in the *Tropique* of *Cancer*, and ſo makes his diurnal revolution in the $23\frac{1}{2}$ Parallel of Declination; I follow this Parallel, the *Tropique*, from the Horizon upwards, and having gone 4 degrees, I meet the ragged arch or hour line of 4. (which is the 120th. Meridian from the South) there croſſeth the ſecond *Almicantar*, and the three and fiftieth *Azimuth* from the North; whereby I learn that at 4. in the Morning, *June* 10, the Sun is 2 degrees high; and in *Azimuth* from the North 53. Thence going on 15 degrees, I come to the hour circle of 5. where cutteth the 10th. *Almicantar* almoſt, and *Azimuth* 64 degrees, and better: going 15 degrees further I come to the Axtree-line, which is the hour circle of 6, and there I find the Suns Altitude 18 degrees, and his *Azimuth* from the North 75 degrees, &c. And look what Altitudes and *Azimuths* I find at 4, 5, 6. &c, in the Morning, the ſame I find at the

the afternoon hours, that have like distance from Noon: because the Eastern and Western Hemisphears are alike, and the same lines serve them both.

Thus you may do in any other Parallel, and for any Star, as well as the Sun; having his Declination given. And so you may make Tables of the Suns Altitude and *Azimuth*, at every hour, and quarter of an hour, if you please, for every day throughout the year: and that as fast as you can write them, without changing the posture of the Planisphear at all.

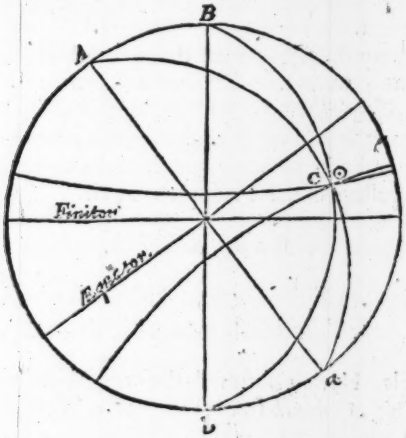
CHAP. XXVI.

The Latitude, Altitude, *and* Azimuth *given, to find the* Declination, *and the* Hour.

EXample. Having observed the Suns Altitude 13. degrees, and his *Azimuth* from the South Westward 28 $\frac{1}{2}$ in our Latitude 52 $\frac{1}{4}$. my Planisphear set in the same manner as Chapter 25. I sought out the 13th. *Almicantar* at the *Limb* of my *Rete*, and followed him inwards till I came between *Azimuth* 28, and 29. there I met the 30th. Meridian, and the 20 $\frac{1}{4}$ Parallel of Declination, by which I gathered that it was 2 of the clock after noon, and that the Sun declined Southward 20 degrees $\frac{1}{4}$.

Note here, that the hour of a Star thus found, is not the hour of the Night, unless the Star happen to be opposite to the Sun; but it is the time the Star lacketh to come to the South, or the time of his course from the South.

CHAP.



CHAP. XXVII.

The Latitude, Declination, *and* Altitude, *given, to find the* Hour, *and* Azimuth.

HEre the three ſides of the Complemental Triangle are given, and the angles A and B ſought.

Example, *March* the 10 in the Morning the Sun being in the Equinoctial, I obſerved his Altitude 32 degrees: the *Finiter* being ſet to my Latitude 52 $\frac{1}{4}$. as before, I went to the 32. *Almicantar* in the *Reet*, and where I found him croſſing the Equinoctial line of the *Mater*, there I conclude was the place of the Sun at the time of my obſervation; and the angle C of my Triangle: there the 30 $\frac{1}{2}$ Meridian paſſing, ſhewed me that the angle A at the Pole was 30 $\frac{1}{2}$, or, that it wanted half a degree, that is 2 minutes of time, of ten of the clock: and there alſo the *Azimuth* 36 $\frac{2}{3}$ from the *South* (or from the North 143 $\frac{1}{3}$) ſhewed me that the angle B at the *Zenith* is 143 $\frac{1}{3}$, the *Azimuth* from the North, and his ſupplement 36 $\frac{2}{3}$, the *Azimuth* from the South.

CHAP.

CHAP. XXVIII.

The Declination, Altitude, *and* Azimuth *of the Sun given, to find the* Hour, *and* Latitude.

IN the Meridional Projection, look in the *Reet* where the *Almicantar* for the Altitude given, and the *Azimuth* given do croſs; and turn the point of the *Reet* where they croſs to the Parallel of the Suns Declination upon the *Mater*: the Meridian that cutteth there ſheweth the hour, and between the Finiter and the Pole, or between the Equator and the *Zenith*, you have the Latitude in the *Limb*.

CHAP. XXIX.

To find the Hour *of the* Night, *by the* Northing, *or* Southing, Riſing *or* Setting *of any* Star.

USe for this the Equinoctial Projection. And if the Star be in your *Reet*, turn him to the North or South of the Meridian line, or to the Eaſt or Weſt part of the Horizon in your Planiſphear, as you ſee him in the Heaven. Then turn the *Label* to the Suns place in the *Ecliptick* of the *Reet*, and it ſhall ſhew the hour in the *Limb*: but if the Star be not in the *Reet*, you ſhall ſupply him by the ſhift uſed Chap. 18.

Example. *March* 10th. I ſaw *Sirius* ſetting in the South-Weſt; and having turned him to the ſame place in my Planiſphear, I laid the *Label* to ♈ 0. which was the Suns place for that day; and it cut in the *Limb* 11. hours 3 minutes paſt noon.

Again, *December* 1. Seeing *Lucida Pleiadum* in the Meridian, I turned the Star till he touched the Meridian line of the *Mater*; then laying the *Label* to ♐ 19. the place of the Sun, I found it was 10. hours 17. minutes at Night.

The ſame Night I ſaw *Ras Aben*, or the brighteſt in the *Dragons head* under the Pole, in the North part of the Meridian; wherefore I placed him on the Meridian line between the Center and *Septentrio*: and the *Label* laid to ♐ 19. ſhewed me it was 12. 36. minutes; that is more then half an hour paſt Mid-night.

CHAP.

CHAP. XXX.

The time of Day *or* Night *given, to find in what Coaſt any Star is: and how much he is diſtant from the* Horizon, *or* Meridian.

LAy the Suns place to the hour given, in the Equinoctial Projection, then may you preſently ſee all the Stars of the *Reet* in what Coaſt they are, whether under the Horizon or above, and how many hours they lack, or are paſt either the Horizon or Meridian.

Example. Sitting within dores at ſeven of the clock on *Chriſtmas* day at Night, I deſired to know what Stars were riſing, and what near the Meridian, wherefore laying ♈ 14. to 7. of the clock afternoon, I ſaw in the *Reet* the *Rams horn*, a little paſt South. The *Plaiades* wanted 1. hour 28. minutes of South, as the *Label* ſhewed me in the *Limb*; ♌ was riſing, but *Cor* ♌. not yet up. I would know now what he wanted of riſing, therefore I turned forward the *Reet* till *Cor* ♌ came to the Horizon, and obſerved how many degrees of the *Reet* paſſed under the *Label* (or by any point of the *Limb*) while the *Reet* turned: and I found that ♈ 0 (and ſo any other point) moved on in the *Limb* 10 degrees in the while that *Cor* ♌ was comming to the Horizon. Whereupon I underſtood that he would riſe 40 minutes after.

CHAP. XXXI.

The Time, *and* Latitude *given, to find the* Altitude, *and* Azimuth *of any* Star: *and thereby to get the knowledge of the* Stars.

FInd the hour of the *Star*, by the former Chapter: And by the *Label* obſerve his Declination: then ſet your Planiſphear in the Meridional Projection, and in the Parallel of the *Stars* Declination, number his hour-diſtance from the South; where the number ends, ſet a needles point; there is the place of the *Star*; and the *Almicantar* and *Azimuth* that cut him there, ſhew your deſire. Example.

Example. I would know the cloudy Star *Præſepe*, in the breaſt of *Cancer* (which indeed is a glimmering light, made up of five ſmal and bright Stars, as by the *Teleſcope* appeareth) This *Præſepe* I found by the laſt Chapter to want 6. hours 21. min. of South; his Declination, found by the *Label*, is 21. degrees North. Therefore ſetting the Finiter to our Latitude 52 $\frac{1}{4}$, I follow the 21. Parallel of North Declination, from the Meridian till I come 5 degrees 15 minutes paſt the Axletree (becauſe I found him 6 hours 21 minutes before the Meridian) there the 17th. *Azimuth*, from the Eaſt Northward, cutteth the Parallel of *Præſepe*; and there cutteth him alſo the 13th. *Almicantar*. Now to find him out, I lay my Planiſphear Horizontally, ſetting the Meridian of my Planiſphear in the Meridian of the Place (by Chap. 3, and 4.) and I turn my *Label* and Sights to the *Azimuth* of *Præſepe* 17 degrees from the Eaſt Northward, and before my Sights I hang up a Plumb-line upon a Pole, to keep the *Azimuth*; then keeping my ſtation, I ſet my Planiſphear upon his edge, or hang him upon a ſtaf with a ſocket, in the *Azimuth* of the Star; ſo that the Plumbet ſhow Altitude 13 degrees (by Chap. 1.) then do the Sights point juſt upon *Præſepe*, and would teach me the Star, if I did not know him before.

Chap. XXXII.

The Latitude *of the Place, the* Declination *of a* Star, *with his* Altitude, *or* Azimuth *given, to find both the* Hour *of the* Star, *and the* Hour *of the* Night.

By this Chapter you may find the time of Night, at any time, by any Star, if he be viſible above the Horizon. Uſe the firſt Mode of the Meridional Projection: and having Obſerved the Altitude or *Azimuth* of the Star, look where that Altitude or *Azimuth* cutteth the Parallel of the Stars Declination, there cutteth alſo a Meridian which ſheweth the hour of the Star, that is, the diſtance of a Star from the Meridian in hours and minutes. And by this hour of the Star, to get the hour of the Night, you ſhall place the Star at the hour found, in the Equinoctial Projection: which done, the *Label* laid to the place of the Sun ſhall ſhew the hour of the Night in the *Limb*.

Example. *December* 25. I obſerved *Procyon* to be full Eaſt, his Declination North, is 6 degrees 3 minutes. In the Meridional Projection I looked where the *Axis* of the *Reet* (which is the Eaſt *Azimuth*) cut the ſixth of the North Parallels, and I found the interſection 1 degree South-ward from the Axtree of the *Mater* (or hour-line of ſix) there alſo cutteth the $5\frac{1}{2}$ *Almicantar*, which ſhewes more then I ſought, that *Procyon* was 5 degrees 30 minutes above the Horizon. Now having the hour of the Star, 6 hours, 4 minutes, before the Meridian, I take the Equinoctial Projection, and having laid the *Label* one degree from *Oriens* South-ward in the *Limb*, I turn *Procyon* to the *Label*, which ſheweth his Hour 6 hours 4 minutes, and leaving him there, I turn away the *Label* to ♍ 14 the Suns place, and it ſhewes me in the *Limb* the time of night 6 hours 26 min. paſt noon. And the ſame I might have found, if inſtead of his *Azimuth*, I had obſerved his Altitude 5 degree $\frac{1}{2}$, the croſſing of that *Almicantar* which the 6th Parallel would have given me the ſame hour of the Star, and further, his *Azimuth*, undeſired.

Chap. XXXIII.

Your Latitude *known, and the* Altitude, *and* Azimuth, *of any* Star, Planet, *or* Comet, *obſerved, and the time of* Night: *how to find his* Right Aſcenſion, *and* Declination.

This Caſe differeth little from the Caſe of Chapter 26. where, from the ſame things given, the Declination and hour was required. For the hour and Right Aſcenſion are in a ſort the ſame thing, only the account of the Right Aſcenſion beginneth alwayes at ♈ 0. and is made in degrees and minutes of a degree. The account of the Hour beginneth at the Meridian, and is made in hours and minutes of an hour. Fifteen whole degrees make an hour, and conſequently 15 minutes of a Degree make one minute of Time, for in every minute of Time there paſſeth the Meridian a quarter of a degree of the Equinoctial. The time of Night is here further required to be given; which may be had by Chap 29. or 32.

The rule. When you obſerve the Altitude and *Azimuth* of the Star, obſerve alſo the time of Night, by Chapter 29. or 32.

and

and to ſave you labour herein, you ſhall do beſt to obſerve your Altitude and *Azimuth*, when ſome known Star is ſeen juſt in the Meridian. Then with your Latitude, and the Altitude, and *Azimuth* of the Star, get by Chapter 26. the Declination, and hour of the Star: Then in the Equinoctial Projection, lay the degree of the Sun to the hour of the Night: thence turn the *Label* to the hour of the *Star*, and you have his Right Aſcenſion in the *Limb* of the *Reet*, between ♈ 0 and the *Label*.

Example. Put caſe I would find the Declination and Right Aſcenſion of *Lucida Pleiadum*. The *Sun* being in *Sagittarius* 10. *December* 2. I obſerved that when *Auſtralis caudæ Ceti* is juſt *South*, *Lucida Pleiadum* was near *South*-eaſt *viz.* in the *Azimuth* 67. from the Meridian, and the Altitude of the ſaid *Star* 45. 0. hence, by Chapter 26. I find his Declination 23 degrees North, and the hour-diſtance from the Meridian 45 degr. that is 3 hours before noon. Then in the Equinoctial Projection (according to Chapter 29.) I ſet *Auſtralis caud. Ceti* in the Meridian line of the *Mater*. and turning the *Label* to 9. of the clock (which is the hour of the *Star*) I find in the *Limb* of the *Reet* (numbring from ♈ 0, to the *Label*) 52 degrees, the Right Aſcenſion of *Lucida Pleiadum*: and where the 23 degrees of the *Label* now touches the *Reet*, there may I prick the *Star* in my *Reet*, if I have him not before; the time of night is eaſily ſeen, by turning the *Label* to the *Suns* place, it ſhewes 7. hours 12 minutes at night: but I need not ſo much as look on that, though by placing *Auſtralis caud. Ceti* in the *South*, I have the time implicitely. The Propoſition therefore, might have been thus made; Your Latitude known, and the Altitude and *Azimuth* of an unknown *Star* obſerved, juſt at the time when any known *Star* is in the Meridian; to find both the Right Aſcenſion, and Declination of the *Star* unknown.

Note alſo, that if you obſerve the unknown *Star* in the Meridian *Azimuth*, you have preſently his Declination, by Chapter 13. and the Right Aſcenſion of *Culmen Cæli*, is the *Stars* Right Aſcenſion.

CHAP. XXXIIII.

The Declination, *and* Right Aſcenſion *of any Star given, to find his* Longitude, *and* Latitude.

LOok the Stars place in the *Mater*, (which is the interſection of the Meridian of his Right Aſcenſion with the Parallel of his Declination) and make a prick there. Then your Planiſphear being ſet in the ſecond Mode of the Meridional Projection, you ſhall preſently find the Longitude and Latitude in the *Reet*: for the *Azimuth* cutting the ſaid prick, ſhewes his Longitude, and the *Almicantar* his Latitude.

Example. *November* 14. 1639. I obſerved a Star of the third Magnitude in the Heart of *Cetus*, which I know to be no common Star, becauſe I had never noted it before, neither could I find it in the Tables of *Ptolemy*, *Tycho*, or any other: the Right Aſcenſion thereof was 30. 13 minutes, the Declination 4. 50. minutes South, as I obſerved by a way which hereafter ſhall be ſhewed Chapter 44. I made therefore a prick with ink in the *Mater* of my Braſs Planiſphear, where the 30th. Meridian (numbred from the Center toward my right hand) and the 5th. Parallel of South Declination do croſs; regarding alſo the odd minutes. Then as ſoon as my ink was drie, I ſet the Finitor in the *Ecliptique* line of the *Mater* with the *Zenith* South-wards; becauſe the Latitude of the Star was South, and I ſaw the 26. *Azimuth* from the Axtree line cutting the prick, and likewiſe the 16th. *Almicantar* cutting about 10 minutes below the prick toward the Finiter. Therefore becauſe in this Mode the *Azimuths* be Circles of Longitude, and the *Almicantars* Parallels of Latitude, (by Book 2. 1.) I conclude the Longitude of *Cor Ceti*, was ♈ 26. and his Latitude 16. 10 minutes South.

When firſt I obſerved this ſtrange Star in the ſaid year 1639. and could find no mention of it in the Tables of *Ptolemy*, *Copernicus*, *Stadius*, *Tycho*, or *Maginus*, I did thereof advertiſe my very good friends Dr. *John Twyſden*, then in *Kent*, and Mr *Samuel Foſter*, Profeſſor of *Aſtronomy* in *Greſham Colledge*, then at *London*; who thereupon made the ſame obſervation of the Star that I had done, for the place of it; and we all agreed that it increaſed in light, and was above the third Magnitude in *December* 1639.

1639. and that it had no perceivable Parallax. And as I was thinking to publiſh ſome brief advertiſment thereof, in the Latin tongue, that *Aſtronomers* beyond the Seas as well as here, might attend the obſervation thereof, Mr *Foſter* wrote me word that he had found the Star pictured in *Bayerus* his Images, which were printed *Anno Domi.* 1616. And in 1640. there came to me through Dr *Twyſdens* hands a Treatiſe of that Star, then newly Printed, by one *Phacylides*, Profeſſor of *Logique* at *Franequers*, whoſe obſervations agreed with ours. But he thought this Star to have been made of the great *Eclipſe* of the Moon which hapned *December* 16. 1638. in the foremoſt foot of ♊. wherein we were not of his mind, you may read this conceipt in his Book pag. 197. This Star doth often appear, and again diſappear; it is ſometime of the 3d. Magnitude, ſometime of the 4th. I have ſeen it oft in the Eaſtern Hemiſphear, ſeldome in the Weſtern. It is loſt ſometimes divers weekes together: this year I could never ſee it, till *February* 2. 165$\frac{6}{7}$. Such as have leaſure for the Study of theſe Arts, may do well to obſerve it, and to ſearch the reaſon of its changes: for which purpoſe I thought it fit to give this notice.

CHAP. XXXV.

The Longitude, *and* Latitude, *of any Star given, to find his* Right Aſcenſion, *and* Declination; *and to place the Stars in the* Mater.

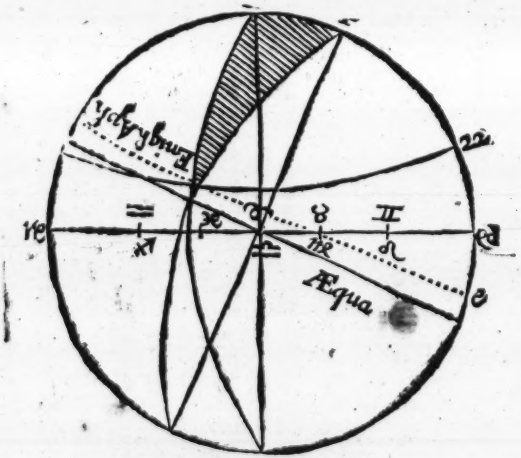
THis Probleme is the converſe of the precedent. The Stars are regiſtred by their Longitudes and Latitudes, becauſe their Longitudes increaſe equally, and their Latitudes remain the ſame. And ſo the Tables are eaſily rectified to any Age, by Addition or Subtraction of a few degrees or minutes of Longitude onely: but the Right Aſcenſion and Declination of the Stars happen to increaſe and decreaſe very unequally, and muſt therefore be calculated from Age to Age, from the Longitude and Latitude whoſe Tables are more certain.

Set the Planiſphear in the ſecond Mode of the Meridional Projection, as in the former Chapter, and bearing in mind that the *Azimuths* here are Circles of Longitude and the *Almican-*

tars Parallels of Latitude, look where the Longitude and Latitude of the Star meet, and there make a prick in the *Reet*; and look what Meridian and Parallel of the *Mater* cut, under that prick they shew the Right Ascension, and Declination of the Star.

Example. *Eniph. Alpharats*, that is, *Os Pegasi*, had by *Tycho's* Tables *An. Dom.* 1600. Longitude ♒ 26,22 minutes, Latitude 22. 07 ½. North. The Finiter set to the *Ecliptique* line of the *Mater*, and the *Zenith* toward the North Pole (because the Stars Declination is North) I count the Longitude of the Star upon the Finiter, (here *Ecliptique*) thus. At the Center say I, is ♈ 0. thence proceeding rightward to the *Limb*, I say, here is ♋ 0. whose Right Ascension is 90. thence returning to the Center, I say, here is ♎ 0. upon the Axis of the *Reet* and Right Ascension 180. upon the Axis of the *Mater*; thence I proceed in the *Finiter* to the other side of the *Limb*, and say here is ♑ 0. bounded by the *Limb* of the *Reet* and Right Ascension 270. bounded by the *Limb* of the *Mater*, which *Limbs* here fall into one Circle; and are *Colurus Solstitiorum*: these numbers I keep, and returning back in the *Finiter* toward the Center, when I am gone 30 degrees, I say, here begins ♒, and going on 26. 22. minutes further, I say, thus far is the Star gone in Longitude. Now here cuts the *Finiter* (by this account) the *Azimuth* 35 ⅓. from the *Limb*; in this *Azimuth* I number the Stars Latitude, by the *Almicantars* 22.07 ½. and at the end of that number in the said *Azimuth* I prick the Stars place. And here I see the 8th. Parallel of North Declination upon the *Mater* cutteth him, and the Meridian 51 ⅓. from the *Limb* shewing the excess of his Right Ascension above 270 which I kept before. Therefore I conclude the Right Ascension of *Eniph. Alpharats, Anno Dom.* 1600. was 321. 20 minutes; and his Declination 8. deg. North.

Another Example. In the Year 1670. *Aldebaran* will have one degree of Longitude more then he had in *Anno Domi.* 1600. therefore he will be in ♉ 5, 12 minutes Latitude 5. 31 minutes South. Now because the Latitude is South, I turn the *Zenith* towards the South Pole (the *Finiter* being placed on the *Ecliptique* line as before) and beginning at the Center, I number on the *Finiter* (here *Ecliptique*) the Longitude of *Aldebaran* 65.12 minutes; and a little beyond the 65th. *Azimuth* I climbe up by the *Almicantars*, toward the *Zenith* 5. 31 minutes to the place of



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of *Aldebaran*. There the 64 $\frac{1}{3}$. Meridian of the *Mater* cutteth under him; ſhewing his Right Aſcenſion: and likewiſe the 16th. Parallel almoſt of North Declination; ſhewing that *Aldebaran* declines North almoſt 16 degrees, though he have South Latitude 5. 31 minutes.

Another way to place the Stars in the *Mater* by their Declination and Horary-diſtance from the Meridian. *See* hereafter Chapter 52.

CHAP. XXXVI.

The Latitude, *and* Declination *of a Star given, to find his* Longitude, *and* Right Aſcenſion.

SEt your Planiſphear in the ſecond Mode of the Meridional Projection, turning the *Zenith* Northward or Southward as the Stars Latitude hapneth to be North or South. Then look where the Parallel of the Stars Latitude in the *Reet* cutteth the Parallel of the Stars Declination on the *Mater*, the *Azimuth* cutting that interſection ſheweth the Longitude of the Star; and the Meridian there cutting ſheweth his Right Aſcenſion.

Example. The Declination of *Spica* ♍, *Anno Dom.* 1670. will be 9 $\frac{1}{2}$. South, the Latitude was always 1. 59 minutes South. Now where the ſecond *Almicantar* cutteth the 9 $\frac{1}{2}$. Parallel of South Declination, there paſſeth the 19th $\frac{1}{4}$. *Azimuth* from the Axis toward my left hand, ſhewing *Spica's* Longitude ♎ 19 $\frac{1}{4}$. and the 17th. Meridian from the Axis, to which I add a Semi-circle (becauſe ♎ 0. is at the Center) and I make 197 degrees the Right Aſcenſion of *Spica* for 1670.

CHAP. XXXVII.

The Longitude, *and* Latitude *of two Stars given, to find their Diſtance.*

MAke one of the Poles of the *Mater* to be Pole of the *Ecliptique*, for this turn, and ſet the Star which hath moſt Latitude at his diſtance in the *Limb*, and turn the *Zenith* to him; count thence by the Meridians the difference

difference of Longitude, till you come to the other ſide of your Triangle; and in that ſide number either the Latitude from the Equator, or his complement from the Pole; at the end of this number is the other *Star*: and the *Azimuth* paſſing from him to the *Zenith*, ſhewes the diſtance. This is done by the ſecond Probleme of Obliquangled Triangles. Book 3. 15.

Example. In *Tycho's* Tables for 1600.

Aldebarans Longitude is ♊ 4. 12 ½. Latitude 5. 31. min. *A.*
Sirius Longitude ♋ 8. 35 ½. Latitude 39. 30 ½. *A.*
Difference of Longitude 34. 23.

I number therefore 39. 30 minutes ½. the Latitude of *Sirius* from the Equator in the *Limb*, or the Complement thereof from the Pole, (all is one,) there I ſet the *Zenith* to ſtand for *Sirius*; then becauſe *Aldebaran* is diſtant from *Sirius* in Longitude 34. 23. minutes, I take the 34 ½. Meridian from the *Zenith*, and where the 5 ½ Parallel cutteth him, there ſay I, is *Aldebaran* (and C of my Triangle) and the *Azimuth* paſſing thence to the *Zenith* meaſureth the diſtance of the *Stars* 46 degrees almoſt.

Chap. XXXVIII.

The Declination, *and* Right Aſcenſion *of any two Stars given, to find their diſtance.*

DO here with the Right Aſcenſion and Declination as you ſhould do with the Longitude and Latitude, by the former Chapter, for the caſe is like, and requireth the ſame manner of working.

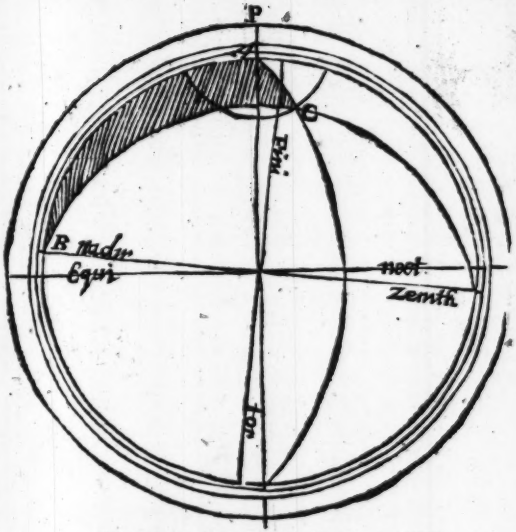
Chap. XXXIX.

The Declination *of a Star or Planet, and his diſtance from a known Star given, to find his* Right Aſcenſion.

BEcauſe this Caſe is the converſe of the precedent, and ſoluble by the firſt Probleme of Obliquangled Triangles, Book 3. 14. an Example, or two ſhall ſuffice.

Anno Domi. 1639. I obſerved the Declination of *Cor Cati* (the ſtrange *Star* mentioned Chapter 34.) to be 4. 50 minutes *South*; and his diſtance from *Lucida Mandibulæ Cati*

to



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to be 13. 04 minutes, and *Lucida Mandibulæ* was Eaſtward from him. The Right Aſcenſion of *Lucida Mandibulæ* then was 40. 56 minutes, his Declination North 2. 40 minutes; therefore I have a Triangle whoſe Sides are all known.

A B the diſtance of *Mandibulæ* from the Pole 87. 20 minutes, I ſet between the Pole and *Nadir* in the *Limb*, becauſe B C will reach beyond the *Finitor*.

For A C the diſtance of the Stars. I ſeek the 13th. Parallel from the Pole. And

For B C I ſeek the 94. 50 minutes *Almicantar*, counted from the *Nadir* (that is the 5th. almoſt above the *Finitor*) and where the ſaid Parallel and *Almicantar* croſs, there is *Cor Cati*, and C of my Triangle: through it there cutteth the *Azimuth* $10\frac{2}{3}$, ſhewing the Difference of the Right Aſcenſion of the Stars; which difference I ſubtract out of the Right Aſcenſion of *Mandibula*, becauſe he was further Eaſt; and there remaineth the Right Aſcenſion of *Cor Cati* 30. 16 minutes, or rather 13 minutes. And I have here alſo numbred by the Meridians, the angle A at *Mandibula* 120 degr. though un-required.

Another Example. *January* 7. $165\frac{5}{7}$. I obſerved by my Braſs Quadrant of 12 inches in Radius, the Meridian Altitude of *Jupiter* 56. 20 minutes, out of which ſubtracting the height of the Equator here at *Eſton* 37. 45 minutes; I found his Declination 18. 35 minutes North; his diſtance then from *Lucida Pleiadum*, I obſerved by my Croſs-ſtaff 5. 12 minutes, and from *Aldebaran* 10. 07 minutes.

The Complement of Decli. of *Lucida Pleiadum* is 67. 00 mi.

The Complement of ♃ his Declination was obſerved 71. 25.

And theſe two Complements with the diſtance of ♃ and *Lucida Pleiadum* 5. 12 minutes, make a Triangle, ſoluble by the firſt Probleme of Obliquangled Triangles; whereby you may find the angle of the difference of Right Aſcenſion of *Lucida Pleiadum* and ♃ is 2. 56 minutes; which added to the Right Aſcenſion of *Lucida Pleiadum* (becauſe ♃ was Eaſt-ward) maketh 54. 44 minutes the Right Aſcenſion of *Jupiter*.

CHAP. XL.

The Latitude *of a Star or Planet, and his diſtance from a known Star given, to find his* Longitude.

DO here with the Longitude and Latitude as you were taught to do with the Right Aſcenſion and Declination, in the former Chapter.

CHAP. XLI.

To find the diſtance of two Stars by their Altitudes, *and their difference of* Azimuth *obſerved at the ſame time.*

THe Complements of the Altitudes are the diſtances of the Stars from the *Zenith*: Set one of the Stars at the Pole, and ſet the *Zenith* as much from him in the *Limb* as the Complement of his Altitude comes to, then conſidering what difference of *Azimuth* the Stars had, take the *Azimuth* of like diſtance from the *Limb* (beginning from that ſide of the *Limb* where the Pole aforeſaid is) and in that *Azimuth* reckon from the Finitor the Altitude of the other Star (or the Complement of his Altitude from the *Zenith*, all is one) at the end thereof is C, and the other Star; and the Meridian that paſſeth from him to the Pole, ſhewes the diſtance of the *Stars*. This caſe is ſo like that of Chapter 37. that he who knowes one may know the other alſo.

CHAP. XLII.

To find the Angles *of* Station *which any two Stars make with the Pole, by their* Right Aſcenſion *and* Declination: *or with the Pole of the* Ecliptique, *by their* Longitude *and* Latitude: *or with the* Zenith, *by their* Altitude *and* Azimuth.

THis Caſe agrees with the ſecond Probleme of Oblique-angled Triangles.

Example. In the Triangle of Chapter 39. made between the

the Pole of the World, *Mandibula Cati*, and *Cor Cati*, I would know the angle at *Mandibula*, which is the angle of his Station. Place the Triangle upon your Planiſphear as in Chapter 39. where the angle unſought, there diſcovered it ſelf to be 125. degrees.

CHAP. XLIII.

To find whether three Stars be in one great Circle, by having their Longitude *and* Latitude, *or their* Right Aſcenſion *and* Declination, *or their* Azimuth *and* Altitude *known.*

EXample. I would know whether the three Stars of *Orions Girdle* be in the ſame great Circle. Here I prick them down, and draw their Circles of Longitude to meet at the Pole of the *Ecliptique*; ſo have you two Triangles joyned in one, and the three Stars in the Baſe of it.

Now firſt, I muſt find by the former Chapter what angle of ſtation the firſt Star hath in the little Triangle P A B, and then what angle of ſtation he hath in the whole Triangle P A C, and if theſe two angles be equal, then be the Stars all in one great Circle, otherwiſe not.

This Probleme may be of uſe to find how the tayle of a Comet pointeth upon the Sun, or upon any other Planet or Star, below the Horizon. But if the three points enquired of, be all in view; I know no better way then to ſtretch a thrid ſtraight at a reaſonable diſtance from your eye, applying it to the Stars; for if the ſame ſtraight line cut them all, they be all in one great Circle, otherwiſe not.

CHAP. XLIV.

If a Comet or Star unknown be ſeen in a ſtraight line with two other known Stars, and his diſtance from one of the known Stars be obſerved; how to find the true place of the Comet or Star unknown.

EXample. *Anno Domi.* 1639. I obſerved that *Mandibula Ceti*, *Gena Ceti*, and the ſtrange Star *Cor Ceti* (ſpoken of Chapter 34.) made a ſtraight line; and by a *Radius*, ſuch as I then had at hand, I obſerved that *Cor Ceti* was diſtant from *Mandibula* 13. 04 minutes. Now if I would find the Longitude and Latitude of *Cor Ceti*, I ſhould uſe the Longitude and Latitude of the other Stars; but becauſe I intend to find firſt his Right Aſcenſion and Declination, I make uſe of their Right Aſcenſion and Declination. The manner of working is alike. The Scheme of the laſt Chapter may ſerve here if you turn it up-ſide down; Then P is the North Pole, A *Mandibula*, B *Gena*, C *Cor Ceti*. P A is the Complement of Declination of *Mandibula* 87. 20 minutes, P B the diſtance of *Gena* from the North Pole 91. 16 minutes, (for he declines Southward 1. 16 minutes) A P B the difference of their Right Aſcenſion 5. 35 minutes.

Therefore I ſet the *Nadir* of my *Reet* as far from the Pole as P is from A, and ſo between them on the *Limb* is the ſide P A. Then for the ſide P B it reacheth from *Nadir* beyond the *Finitor* 1. 16 minutes, therefore in the 1 $\frac{1}{4}$. *Almicantar* I number from the *Limb* 5. 35 minutes, the difference of Right Aſcenſions for the Angle A P B, and where the 1 $\frac{1}{4}$. *Almicamar* and the 5 $\frac{1}{2}$. *Azimuth* do meet, there is B for *Gena*: thence I go in a Meridian to the Pole at A, and as I go I number the diſtance of B and A, that is, *Gena* and *Mandibula*, 7 degrees almoſt; and I obſerve that this Meridian is the 125. Meridian from the *Limb*; ſo much is A, the angle of ſtation at *Mandibula*.

Now

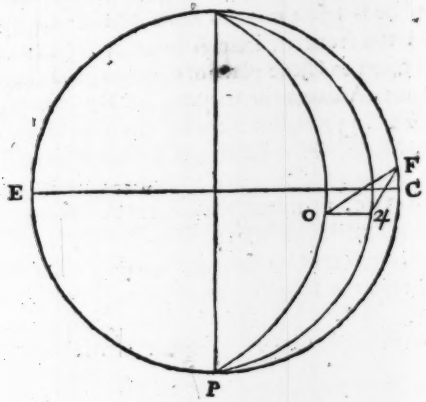
Now I ſay, in this Meridian alſo is *Cor Ceti*, becauſe he is in a right line with the other two Stars which are cut by this Meridian: and he is 13. 4 minutes from *Mandibula*, by obſervation; therefore I run from the Pole A ſo many degrees in this Meridian, and ſo come to C, the place of *Cor Ceti*, and there cutteth the 4. 50 minutes *Almicantar*, ſhewing the Declination of it, and the *Azimuth* 10.43 minutes, ſhewing his difference of Aſcenſion from *Mandibula*; which difference I ſubduct from the Right Aſcenſion of *Mandibula* (becauſe *Mandibula* is further Eaſt,) and there remains 30. 13 minutes, the Right Aſcenſion of *Cor Ceti*: which being found, you may find his Longitude 26 degrees, Latitude 16. 10 minutes, by the 34th. Chapter: Obſerve how your Triangle lies in the Planiſphear, where *Nadir* is uſed for the North Pole, the North Pole is the place of *Mandibula*, and the 125. Meridian repreſents the great Circle cutting the three Stars.

CHAP. XLV.

The diſtance of a Planet from two known Stars being Obſerved, to find his Longitude and Latitude.

IT is true that Mr. *Blagrave* ſaith, Book 5. 25. that in Queſtions of this ſort it is harder to conceive how they ſhould be reſolved, then to reſolve them. And therefore he adviſeth to draw a rude Scheme of your work, agreeable to the Meridional Projection of your Planiſphear, after this manner.

December the 28. 1656. I obſerved ſomewhat groſly by my Croſs-ſtaff that ♈ was between the *Hyades* and the *Pleiades*, diſtant from *Aldebaran* 9.49 minutes, and from *Lucida Pleiadum* 5. 26. and to the Southward of the Stars. I draw therefore a rude Scheam repreſenting ſomewhat near the poſture of theſe three Stars. E C is *Ecliptique*, and P his South Pole, P C the Circle of Longitude of the Weſterly Star *Lucida Pleiadum* ♉ 25. 12 minutes, and becauſe he hath North Latitude 4 degrees, I place him at F; *Aldebaran*, whoſe Longitude is ♊ 5. Latitude South 5. 31 minutes, I place ſomewhat like at O, and *Jupiter* I place below the line drawn between them, and nearer to the *Pleiades* then to *Aldebaran*, as I obſerved his ſituation in the Heaven.



That I ſeek now here, is P ♃, the complement of *Jupiters* Latitude; and F P ♃, his difference of Longitude from *Lucida Pleiadum*.

Firſt, in the great Triangle F P O, I have the angle P, the difference of Longitude between *Lucida Pleiadum* and *Aldebaran* 9 degrees 48 minutes, and the including ſides P O 84. 29. (*Aldebaran* diſtance from the South Pole) and P F 94. (diſtance of the *Pleiades* from the South Pole) and hence by the ſecond Problemes of Obliquangled Triangles Book 3. 15. I get at once, the Baſe O F, diſtance of *Lucida Pleiadum* and *Aldebaran* 13. 45 minutes, and the angle of ſtation at F, *viz.* P F O 45. 28 minutes.

2. Then in the Triangle F O ♃, whoſe three ſides are now known, I get the angle O F ♃ (by the firſt Probleme of Oblique Triangles, Book 3. 14.) 35. 14 minutes) which being Subducted from the angle O F P, leaveth the angle P F ♃ 10. 14 minutes.

3. In the Triangle P F ♃, having now the angle F. and the ſides including it, I get the third ſide P ♃, the Complement of ♃ Latitude 88. 39 minutes (by Oblique Problemes 2. Book 3. 15.)

And

And lastly the three sides in the Triangle P F ♑ being now known my Planisphear unmoved will shew me F P ♑ 58 minutes (by the Probleme 1 Oblique Triangles.) which 58 minutes being added to the Longitude of *Lucida Pleiadum* maketh up the Longitude of ♑ ♒ 26. 10 minutes, and his Latitude was even now found 1. 21 minutes South.

CHAP. XLVI.

To find the Culmen Cæli, *and the* Altitude *thereof, at any time proposed.*

Culmen Cæli is the degree of the *Ecliptique* which is cut by the Meridian of your Place.

Use the Equinoctial Projection, where having laid the place of the Sun to the Hour proposed, look what degree of the *Ecliptique* is cut by the Meridian line, and you may number his Altitude from your proper Horizon.

Example. *March* 29. 1652. I laid the Suns place ♈ 19. 11 minutes to 32 minutes past 10. of the Clock before noon, and in the Meridian I saw ♐ 25 $\frac{1}{2}$ Culminating. And for his Altitude I looked where my Horizon cuts the South part of the Meridian (at 52 $\frac{1}{4}$ from the Center) and from that cutting I count in the Meridian to the *Ecliptique* 36 degrees, the Altitude of *Culmen Cæli*.

But note, That if ♐ had been a North Signe, I must have counted first to the *Limb* 37. 45 minutes, and thence back again to *Culmen* 1 $\frac{3}{4}$. in 39 $\frac{1}{2}$.

CHAP. XLVII.

To find the Ascendent *or* Horoscope, *and the other three Principal Houses, for any time proposed.*

Astrologers divide the Heaven into twelve Houses, of which, four are principal. The First House, which beginneth at the Ascendent or Rising point of the *Ecliptique*. The Fourth, which beginneth at *Imum Cæli*, or Midnight. The Seventh, which beginneth at the Descendent point of the *Ecliptique*. And the Tenth, which beginneth at *Medium Cæli*, or *Culmen*. These

Theſe be the four Cardinal points, and the *Aſcendent* and *Deſcendent*, and likewiſe the *Medium* and *Imum Cæli*, are alwayes oppoſite one to the other, ſo that one being known, the other is known alſo.

To find theſe points, uſe the Equinoctial Projection, and there lay the Suns place to the hour propoſed: then the degree of the *Ecliptique* riſing in your Horizon is *Aſcendent*, and you ſhall ſee the ſame degree of the oppoſite Signe Deſcending in the Weſt part of the Horizon; and look what degree toucheth the South part of the Meridian, that is, *Medium Cæli*, and the ſame degree of the oppoſite Signe ſhall be in *Imo Cæli*, that is, in the North and *Subterranean* part of the Meridian.

Example. *March* 29. 1652. I obſerved the great *Eclipſe* of the Sun, the middle whereof hapned at *Eſton*, at 10 hours 32 minutes 04 ſeconds before noon in apparent time, at what time the Sun was darkned digits 11. $22\frac{1}{2}$, in ♈ 19. 11 minutes. I would know for this time the Figure of the Heavens.

Therefore laying the *Label* to 10. 32 minutes before noon, and bringing ♈ 19. 11 minutes to the *Label*, I ſee in our Horizon ♋ 24. 7 minutes riſing, and ♑ 24. 7 minutes ſetting. In the Meridian above the Horizon I ſee ♐ 25. 19 minutes: and in *Imo Cæli*, toward *Septentrio*, ♊ 25. 19 minutes.

Chap. XLVIII.

To find the beginnings of the other eight Houſes.

THere be ſix great Circles, by which the twelve Houſes are diſtinguiſhed. They be called Circles of Poſition: and ſo they call the reſt of the Circles which ſerve to ſubdivide the Houſes. They be all Horizons to ſome Country or other in the World, and therefore are moſt fitly repreſented by the Horizons of the *Mater*. The Firſt Houſe beginneth alwayes at the *Aſcendent*: and the reſt follow in order according to the Sequel of the Signes. But *Aſtrologers* are not well agreed about their ſituation. For 1. *Some* will have the domifying Circles drawn from the Poles of the *Ecliptique* through every 30th. degree thereof, as *Ptolemie*. 2. Some draw them from the Poles of the World, through every 30th. degree

degree of the Equator; as *Alcabitius*. 3. Some draw them from the interſections of the Meridian and Horizon, through every 30th. degree of the Equator; as *Regiomontanus*. 4. Some draw them from the ſame interſections, by every 30th. degree of the *Prime Vertical* or Eaſt *Azimuth*; as *Campanus*. Yet every *Aſtrologer* will pretend he can tell you your Fortune, though they go about it ſo divers wayes, that they may be all falſe, and but one of them can be true: and no Man hath ſhewed any better reaſon for his way then another, but his own opinion.

If you will follow the firſt or ſecond way, the matter is plain. For in the firſt way every 30th Circle of Longitude reckoned from the Aſcendent downwards, and ſo round, is a *Domifying* Circle: and likewiſe every 30th. Meridian from the Aſcendent is a *Domifying* Circle in the Second way. And if you know but what Longitude a Star hath, you preſently find in what Houſe he is, after the firſt way. And if you know the Right Aſcenſion of a Star, and of the Aſcendent, you preſently find in what Houſe he is, after the ſecond way.

But if you will uſe the third way (now commonly uſed) you ſhall ſet the *Zenith* line of the *Rete* to the Latitude, and ſo the *Azimuths* are your Circles of Poſition; then look what *Azimuth* cutteth every 30th. degree of the Equinoctial, that is a *Domifying* Circle; and you ſhall reckon here from the *Limb*, which ſhall ſtand for the beginning of the 10th. Houſe, and ſo in our Horizon 52 ½. the fourty third *Azimuth* cutteth the 30th. degree of the Equator, ſerving the 11th. and third Houſe: and the *Azimuth* 70 ½ cutteth the 60th. degree of the Equator, ſerving the 12th. and ſecond Houſes: and becauſe I know that on the other ſide the Center the Interſections will be like, I look no further.

But now I muſt get the Depreſſions of theſe Circles under the Pole in this manner. I number in the fourty third *Azimuth* the Latitude of my Place from the *Zenith*; to the end of which number I lay the *Label*, and I ſee the *Azimuth* cutting on the *Label* 32 ½ for the depreſſion of that Circle. And in like manner, laying the *Label* upon the 52 degrees ½ of the *Azimuth* 70 ½ I find on the *Label* his depreſſion 48 degrees; by the third Probleme of Rectangl. Triangles, and the third Variety Book 3.5.19.

Theſe Horizons therefore I chooſe out in the *Mater*, *viz.* 32 ½, and 48. for theſe with the Meridian and Horizon of my Place,

ſhall ſerve to get the Houſes for ever, in my Latitude: for the 32 ½ Horizon ſhall be the beginning of the 11th. and third Houſes; and the 48th. the beginning of the 12th and Second. Thus have I the Circles of Poſition of the 11, 12, 2, and 3. Houſes: and the 10th. and firſt, are had by the former Chapter: and theſe ſix being had, I have all; for oppoſite Hemiſpheares are alwayes alike, and one deſcription ſerveth both.

Chap. XLIX.

To know what degree of the Ecliptique *is in the beginning of every Houſe.*

DO as in this Example. By Chap. 47. I had the degree *Culminating* in the middle of the great *Eclipſe* there mentioned, ♐ 25 ½. Firſt I lay ♐ 25 ½ to the Axtree line at 6 in the morning, where it lieth as in a Right Horizon; thence I move it 30 degr. Southward in the *Limb*, *viz.* to 8 of the clock, and in the Horizon of the 11th. houſe (32 ½) I ſee ♉ 7 degrees ſetting, the ſaid degrees of Culmination: 30 degrees further, *viz.* to 10. a clock, I ſee in the Horizon of the 12th. Houſe (48.) ♊ 24 ½. And ſetting the ſaid degree of Culmination to the Noon-line, I ſee in our Horizon (52 ¼ which begins the firſt Houſe) ♋ 24 ½ aſcending. And ſetting the ſaid degree 2 hours further on, I ſee in the Horizon of the ſecond Houſe (48) ♌ 13. And ſetting the ſaid degree to 4 a-clock, I ſee in the Horizon of the third Houſe (the 32 ½) ♍ 1.

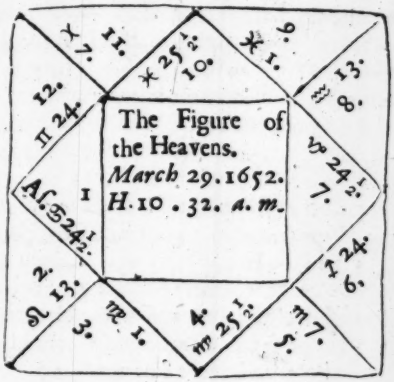
Thus have I the degrees of the *Ecliptique* in the beginning of 6 Houſes, and the 6 Houſes oppoſite begin with the ſame degrees of the oppoſite Signes.

Chap. L.

Another way to find what degree of the Ecliptique *is in the beginning of every Houſe, and thereby to ſet a Figure more eaſily then by the former Chapter.*

IT was found by Chapter 48. that the *Azimuths* 43. and 70 ½ are evermore *Domifying* Circles in our Latitude (52 ¼.) and how you may find them for any other Latitude was there

there ſhewed. There I reckoned them from the *Limb*; but here I ſhall reckon them from the Axis; and ſay, the *Azimuth* 47. ſerveth the 11th. Houſe; the 19 ½ ſerveth the 12th. the Axis for the firſt, and ſeventh; the 19 ½ below the Axis for the ſecond; the 47th. for the third; the Meridian for the 10th. and 4th. You may therefore mark the ends of theſe *Azimuths* in the *Finitor*, ſetting 12 to the 19 ½ above the Axis, (here made Horizon for this turn) and 11.



at the 47th. at the Axis, 1. then at the 19 ½ below the Axis, write 2. at the 47th. write 3. and at the *Limb* 4.

Your Houſes being thus diſtinguiſhed on the *Reet*, get the degree of Culmination, and the Altitude thereof, by Chapter 46. then ſet the *Zenith* under the North Pole, ſo much as the Altitude of the Culmination comes to: and if the Aſcendent be a North Signe, let the Pole be toward your left Hand; and contrary if it be a South Signe: ſo ſhall the Axis of the *Reet* be Horizon, and the Pole *Culmen Cæli*.

Next get the Aſcendent by the 47th. and his Amplitude by the 16th: this Amplitude you ſhall number in the Axletree of the *Reet* from the Center alwayes to your left Hand, or toward *Septentrio*; and mark what Meridian there cuts the Axletree of the *Reet*, in that degree of Amplitude; that Meridian ſhall be your *Ecliptique* for this time: follow him up to the Pole, and you trace out the arch of the *Ecliptique* from the Aſcendent to mid-heaven: and if you go down in his match to the like degree of Amplitude on the other ſide of the Center, there is the Weſtern arch of the *Ecliptique* from the mid-heaven to the Deſcendent; and here you may ſee every degree of the *Ecliptique* above the Horizon, and in what Houſe it is, without any more courſing after them.

Example. ♐ 25 ½ was Culminating; his Altitude 36 degrees; the Aſcendent had ♋ 24. whoſe Amplitude is 36 ⅓. Setting the *Zenith* therefore 36 degrees to the right Hand under the Pole, I number in the Axtree-line of the *Reet*, from the Center to my left Hand the Amplitude of the Aſcendent 36 ⅓. there cometh the 23. Meridian from the Center, who muſt ſerve for the *Ecliptique*. Now becauſe it is troubleſome to number the degrees of the Signes backward, I will begin at the Deſcendent 36 ⅓ from the Center on the other ſide: and ſay, Here is ♍ 24 degrees deſcending, (becauſe ♋ 24. was aſcending,) hence I count on toward the *Culmen*, till I come to the *Azimuth* 19 ½, (which is the *Domifyer* of the 12th. and 8th. Houſes,) and here I ſay, begins the 8th. Houſe in ♒ 13. for there are but 19 degrees from the Deſcendent hither: hence I count to the 47th. *Azimuth* (the *Domifyer* of the 9th. and 11th. Houſes) and there I count ♐ 1 degree, for the beginning of the 9th. Houſe: hence I number on to the Pole, and there I happen on ♐ 25 ½, the *Culmen* and beginning of the 10th. Houſe. Thence I number on the other ſide of the *Maters* Axtree, in the twenty third Meridian, toward the Aſcendent, and I find the 47th. *Azimuth* cuts ♉ 7 degrees for the beginning of the 11th. Houſe; but the 19 ½ *Azimuth* which ſhould ſhew me the 12th. Houſe, is cut off by the *Finitor*, and I am left to ſeek him elſe where: And to find him I need but turn about my whole Planiſphear (the *Reet* unmoved) and make the other Pole *Culmen* for this turn, and then I find among the *Azimuths* that peece of my *Ecliptique* which I wanted in the former poſture; and I may reckon on him between the Aſcendent and the *Azimuth* 19 ½, 29 ½, and thereby ſee that ♊ 24 ½ is in the beginning of the 12th. Houſe: ſo have I 6. of my Houſes, and may by them find the other 6, (as was ſhewed Chapter 48.) and ſet them down as in the Figure.

Chap. LI.

A third way to ſet a Figure with leſs labour.

LEt the Meridians and *Azimuths* here change their offices in which they ſerved in the former Chapter: that is, let the 19 ½ and 47th. Meridian on both ſides the Axis of the *Mater* be *Domifyers*; and let the 23 *Azimuth*

nuth be *Ecliptique*: and to that purpoſe, ſet the *Zenith* above the Pole, according to the Altitude of *Culmen* 36 degrees, and make the Axis of the *Mater* Horizon. Then beginning as you did before at the Deſcendent, go up in the *Ecliptique* till you come to the Meridian $19\frac{1}{2}$, and follow the *Almicantar* that there cutteth to the *Limb*, and there make a mark for the 8th Houſe; then mark where the ſame *Ecliptique* cuts the next *Domifyer* (the 47th. Meridian) and follow the *Almicantar* from that point to the *Limb*; prick there the 9th. Houſe: the *Zenith* is the 10th; thence go toward the Aſcendent, and do in like manner; making pricks for the 11th. and 12th. Houſes: alſo in the *Limb* of the *Reet* at the end of that *Almicantar* which cutteth the beginning of the Houſes in the *Ecliptique*. Then in the *Zodiaque* of the Ring, look the degree of Culmination, and ſet the *Zenith* of the *Reet* to it; and the *Label* laid to theſe pricks, ſhall ſhew you preſently in the *Zodiaque* the degrees for the beginning of every Houſe.

CHAP. LII.

How to place any Star *or* Planet *in his proper Houſe.*

IN the Equinoctial Projection, get the Stars Hour diſtance from the Meridian, thus. Lay the Suns place to the hour propoſed: then turn the *Label* to the Star (or to his Right Aſcenſion if he be not in the *Reet*) and it ſhall ſhew in the *Limb* how many hours and minutes the Star is paſt or ſhort of the Meridian: get alſo the Stars Declination North or South, by the *Reet*, or by the 35. or ſome other Chapter; and where the Parallel of the Stars Declination croſſeth the hour of the Star in the *Mater*, there is his place for this turn: therefore having made a prick with ink for him there, ſet the *Zenith* line to your Latitude, and having your *Domifying Azimuths* marked upon the *Reet* (as Chapter 49. 30.) you ſhall preſently ſee in what Houſe the Star is.

Example. 1652. *March* 29, 10. hours 32 minutes before noon, I would know in what Houſe the *Pleiades* are. The hour of *Lucida Pleiadum* for that time is 8. 14 minutes after midnight: the Declination is 23 degrees North. I number therefore in the 23. Parallel of North Declination from the Atree

of the *Mater* to the Meridian 33 ½, there is the place of *Lucida Pleiadum*, where I prick him down; and ſetting the *Zenith* line to the Latitude, I find the 39 *Azimuth* or Circle of Poſition cuts him: by which I ſee he is 8 degrees from the beginning of the 11th. Houſe, for that begins at *Azimuth* 47, as appeares Chapters 49, 50.

CHAP. LIII.

To find the diviſion of the Houſes, according to Campanus.

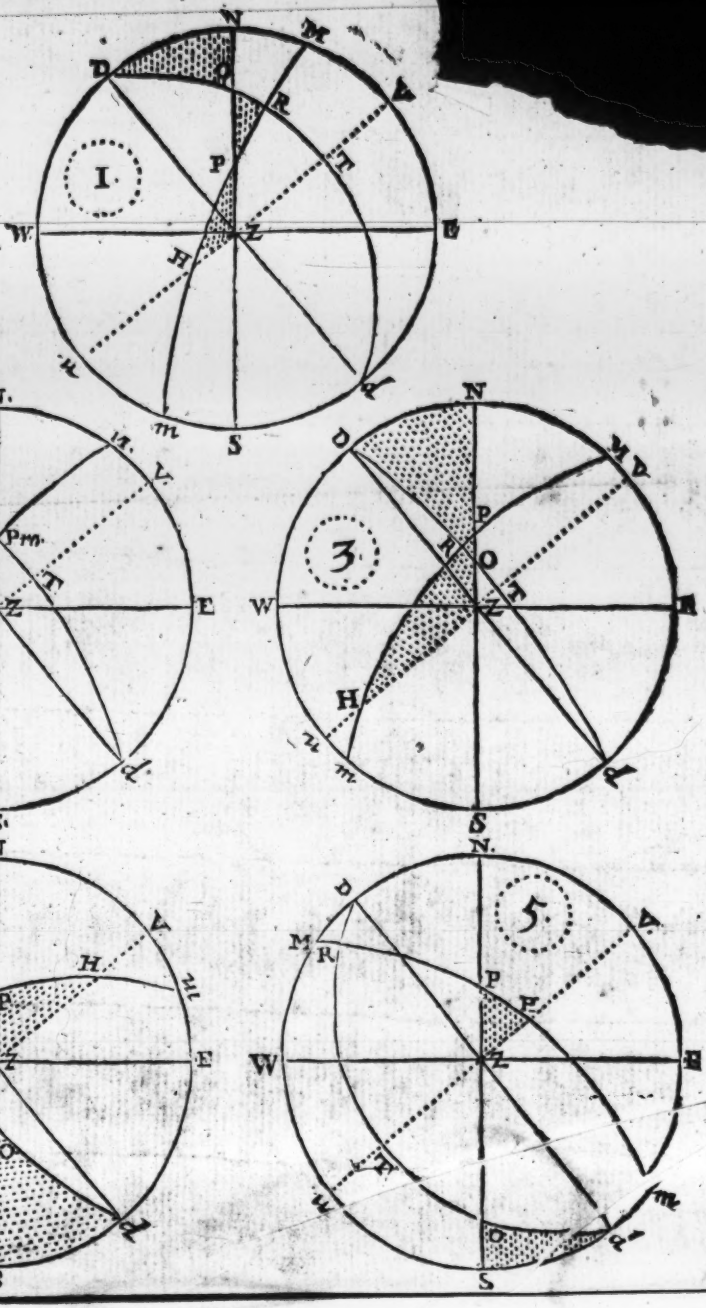
CAmpanus begins the Houſes at every 30th. degree of the Eaſt *Azimuth*, accounting from the Aſcendent in the Sequel of the Signes, as was ſaid Chapter 48. Therefore if you will uſe his way, ſet the *Zenith* line to the Latitude, and the *Finitor* ſhall become the Eaſt *Azimuth*; and every 30th. *Azimuth* from the *Limb*, or Axtree line, is a *Domifying* Circle: you ſhall therefore in ſtead of *Azimuths* 19 ½, and 47. (which are *Domifyers* after *Regiomontanus* for our Latitude, as was ſhewed Chapters 49, 50.) take *Azimuths* 30. and 60. on both ſides the Axtree line, which are diſtinguiſhed to your hand; and with theſe *Domifyers* you ſhall work in all reſpects as you did with the other in the three former Chapters.

CHAP. LIIII.

How to Direct a Figure.

TO Direct is to turn on the Sphear, till ſome Star in the ſecond Houſe come into the firſt, or contrarily: and ſo obſerve how many degrees the Equinoctial is moved forward or backward in the ſame time.

Place the Star or Planet on the *Reet*, or on the *Label*, (as Chapter 18. is taught, then in the Equinoctial Projection (as Chapter 47.) ſet the Aſcendent at your Horizon, and note the degree Culminating: then turn on the *Reet* forward or backward till the Star come to the Horizon: then lay the *Label* on the degree which Culminated before; and mark how many degrees of the *Limb* he is diſtant from noon, ſo many degrees of the Equator have paſſed the Meridian and Horizon: which *Aſtrologers* take to ſignifie ſo many years before the effect promiſed by the ſaid Star ſhall happen.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Appendix, *Concerning* Judiciarie Aſtrologers.

SOme learned Artiſts may perhaps think that theſe 8. laſt Chapters pertaining to *Aſtrologie* might be ſpared; and I think ſo too: but that I foreſee they may be of uſe to ſuch as would examine the errors and fallacies of *Aſtrologians*. *Aſtrology* of old was no more then *Aſtronomy*, an Ingenuous Science, leading a Man to the knowledge of that which may be known, and ought to be Studied, the greatneſs and wiſdome of God manifeſted in his works. But *Aſtrology*, as the word is now commonly uſed, is μάγος *Act.* 19. 19. and ψευδώνυμος γνῶσις 1. *Tim.* 6. 20. Teaching Men to ſearch into that which neither can be known, nor ought to be Pryed into; Contingencies to come, which belong to God onely to know, and reveal. *Eſa.* 41. 23. *Tell us things to come*, (ſaith he) *that we may know that ye are Gods.* And *Favorinus* an Heathen *Philoſopher* could ſay, *Tollitur quod maxime inter Deos atq; homines differt, ſi homines quaq; res omnes futuras præſcirent.* This kind of *Aſtrology* God derides by his Prophets, and forbids to his People, *Eſa.* 47. 12, 13. He ſaith to *Babylon*, where this Art then flouriſhed. *Stand now with thine Inchantments, and with the Multitude of thy Sorceries, wherein thou haſt laboured from thy Youth; if ſo be thou ſhalt be able to profit; if ſo be thou mayeſt prevail. Thou art wearied in the Multitude of thy Counſels: Let now the Aſtrologers, the Star-gazers, the monethly prognoſticators ſtand up, and ſave thee from theſe things that ſhall come upon thee.* Jerem. 10. 2. *Thus ſaith the Lord, Learn not the way of the Heathen, and be not diſmayed at the ſignes of Heaven: for the Heathen are diſmayed at them. For the cuſtomes of the people are vain.*) And it was one of the preſages of their Captivity, when they began to be repleniſhed with thoſe Eaſtern Arts, and to be South-ſayers, like the *Philiſtims*, *Eſay* 3.

I have ſeen what gloſſes have been put upon ſome of theſe Texts: and how the judgements of Mr *Perkins*, and Mr *Gataker*, are ſlighted by ſome late pretenders to *Aſtrology*; whereat I wonder not: having ſeen the works both of the one ſide, and of the other.

Judi-

Judiciary Aſtrology hath two parts, The *Meteorological*, and the *Genethliacal*. And againſt both there are theſe juſt exceptions. 1. Whereas about the time of *Nabonaſſar*, or ſoon after, the Heaven was divided upon the Poles of the *Ecliptique* into 12. Spaces, called *Dodecatemoria* and Signes: and the *Aſtrologers* of the next Ages aſcribed to theſe ſpaces certain vertues or Powers over the ſeveral parts of Mans Body, and over the ſeveral Countryes and Nations of the World: eſpecially by reaſon of the qualities they ſuppoſed to be in the fixed Stars; which then occupied thoſe ſpaces: their Rules are ſtill obſerved, notwithſtanding that thoſe Stars are removed into the ſucceding ſpaces. For thoſe Stars which in *Nabonaſſars* time were in the *Dodecatemorion* of ♈, are all removed into the *Dodecatemoria* of ♉, and ♊; and thoſe of ♐ and ♒ are come in their roomes: for the fixed Stars are found to paſs through a whole Signe, that is, a 12th. part of the Compaſs of the Heaven, in 2118. Years; and it is now above 1400. Years ſince *Ptolemie* wrote, and above 2400. ſince *Nabonaſſar* began his Reign. 2. That *Aſtrologers* ſcarce look beyond the *Zodiaque* for their *Aſpects*, whereas the fixed Stars on the North and South may have, for ought they know, as operative configurations with the Planets, as the Planets one with another. 3. That their own Rules are ſo manifold, and the Planets and fixed Stars and their Aſpects alſo are ſo many, and ſo divers in qualities and degrees, that it is impoſſible to judge what effect the mixture of thoſe influences ſhall produce; eſpecially conſidering that from the beginning of the World to this time, the Heavenly bodies never had twice the ſame poſture: and therefore there wants experiment to build the Art upon.

For the *Meteorological* part, I was much helped by the Studies of my Father, who for 10. Years did moſt curiouſly obſerve all changes of Wind and Weather, while I was waking; and noted them daily over againſt the dayes in *Maginus* his *Ephemerides*. His concluſion was, that he could find no certainty in the rules of *Aſtrology* commonly received, nor frame any other upon his experience. Yet had I a mind to try a little further, and about the Year 1631. and forward for ſome years, I made dayly Obſervations of all Winds and Weather at home, and got alſo the beſt information I could by Letters from Friends abroad, by relation of Travellers, *Journals* of Sea-men, *Currantoes* (as they were

were then called) *Mercurius Gallabelgicus*, &c. And I found ſo great diverſity of Weather in the ſame Climate, and ſometime in places ſcarce three degrees diſtant in Longitude or Latitude, that I diſpaired of Prognoſticating Weather, till I could learn which way the Wind would liſt to blow. This among my Obſervations is memorable, that the Weather *Capt. James* had in his Voyage, Wintering and return from the Mud-land Sea of *America*, was very divers from ours, and oft times contrary; and all the agreement I could find, was, that one day when it Thundred in *America* very ſore, we had Thunder 18. hours after: yet he was many moneths in *Charleon Iſland*, which is in our Latitude; where his Ship was ſo Frozen, and the Sea ſo full of Ice, that he could not ſail till *May*. And I know a learned Gentleman that uſed for a recreation at *Chriſtmas* time to put a Dozen new Almanacks into the hands of ſo many of his ſervants, and ſet them to read in order the ſeveral judgements of the Prognoſticaters about the Weather; wherein he found as good ſport as *William Duke* of *Mantua* did in reading the judgements of ſeveral *Aſtrologers*, upon a Figure erected upon the Nativity of his young *Mule*.

For the *Genethliacal* part, ſince Planets ſignifie diverſly according to the Houſes in which they are, it were very needfull for Men of this craft, firſt to demonſtrate how the Houſes ought to be divided, before they undertake to give any judgement: but herein they are not agreed: thoſe Stars which after *Ptolemy* are in one Houſe, and ſignifie thus; after *Regiomontanus* are in another Houſe for the ſame time and place, and ſo ſignifie otherwiſe. Of the four wayes above mentioned Chapter 48. I cannot ſay which is beſt: but that of *Regiomontanus* which is now moſt followed, and called by ſome the Rational way, ſeemes to me the moſt Irrational of all, becauſe of the very unequal diviſion of the Houſes: for let a man Erect a Figure for *Wardhuys* in *Norway*, after that way, and he ſhall find the 4 Houſes next the Meridian, *viz.* 3, 4, 9, 11. hugely great, each of them containing above a ſeventh part of the Sphear; and the 4 Houſes next the Horizon each of them not to contain a twenty fourth part; he ſhall alſo obſerve that all the Stars within 48 degrees of either Pole (which take up a full third part of the Sphear) are perpetually confined to two Houſes for that Parallel; though in warmer Climates ſome of them have a little more liberty; but *Ptolomie* and *Al-*

cabitius gives every Star the Liberty of all the Houſes, and *Campanus* Impriſons but a few.

I could never ſee any good reaſon why the influences of the Stars ſhould make more impreſſion upon the Child in the moment of his Nativity, then they did at any time before in the Womb. If mines in the Earth are not hidden from the influences of the Stars, neither is the Child in the Mothers belly. If the Stars have ſuch operation on Men in their Nativity, it is rationall to think they have more force in their firſt conception, when the matter is fluid and more apt to receive impreſſion, then when the Child is ſhaped, and the temper more confirmed: and this *Johannes Angeli* an old *Aſtrologer* conſidering, framed a Table to diſcover to a minute the time of conception, by the time of the Birth given, where he extends the time of geſtation to 40. Weeks, and (as I remember,) 6 dayes over; but he doth not tell us whether he made that Table by experience, or divination; nor how many experiments he had uſed for the triall of it.

Favorinus once demanded of theſe *Genethliacal* men, who pretend to know mens Fortunes by the Poſitions of the Stars in their Nativity. How it comes to paſs that thouſands of people, of both Sexes, of all Ages, born in ſundry places, and under ſundry configurations of the Stars, have hapned to periſh in the ſame hour and moment, and by the ſame misfortune, as by Shipwrack, Stormes of War, Earth-quakes, fall of Buildings, and ſuch like accidents? And whether this fate could have been foreſeen in all the Figures Erected for their ſeveral Nativities? Which demand I think never yet received any good anſwer.

This alſo I have long obſerved that no Man (ſo far as my knowledge and intelligence reacheth) are ſo Fortunate in ſetting Figures for diſcovering things loſt, or Prognoſticating of Life and Death, as ſome who ſcarce know *Charles Wain*, nor any Planet in the Skie beſide the Sun and Moon: and ſome of theſe have given out that I allowed of their practiſes, before ever they conſulted me, and ſo gave me occaſion to make this digreſſion. He that would ſee more of this argument may read what my *Lord Howard*, ſometime *Earle* of *Northampton*, and Mr *Perkins* have written thereupon. *Pliny Book.* 30. *Chapter.* 2. hath recorded *Nero's* experiment and judgement of this Art. *Species magiæ plures ſunt; namq; & ex Aquâ, & ex Spheris, & ex Aere, & Stellis,*

Stellis, & Lucernis, ac Pelvibus, securibusq;, & multis alijs modis divina promittit: preterea umbrarum, inferorumq; colloquia: quæ omnia ætate nostrâ princeps Nero *vana falsaq; comperit: quippe non Citharæ tragiciq; cantus libido illi major fuit, fortuna rerum humanarum summa gestiente in profundis animi vitijs: Primumq; imperare Dijs concupivit, nec quicquam generosius voluit. Nemo unquam ulli artium validius favit: Ad hæc, non opes ei defuere, non vires, non discendi ingenium; aliaq; non patiente mundo, Immensum & indubitatum exemplum est falsæ artis, quam dereliquit.* Nero, as if he had said, What shall the Man do that comes after the King? And a little after, *Proinde ita persuesum sit, intestabilem, irritam, inanem esse, habentem tamen quasdam veritatis umbras, sed in his veneficas artes pollere, non Magicas.* The judgement also of *Favorinus*, a learned *Philosopher*, is worthy to be here rehearsed, as it is reported by *A. Gellius Noct. Attic.* 14. 1. With whose words I will end this digression.

Cavendum ne qua nobis isti Sycophantæ *ad fidem faciendam irreperent, quod viderentur interdum vera effutire aut spargere. Non enim comprensa (inquit) neque definita, neq; percepta dicunt, sed lubrica atq; ambagiosa conjectatione nitentes, inter falsa atq; vera pedetentim quasi per tenebras ingredientes eunt: & aut multa tentando incidunt repente imprudentes in veritatem; aut ipsorum, qui eos consulunt, multa credulitate ducente perveniunt callide ad ea quæ vera sunt: & iccirco videntur in præteritis rebus quàm in futuris veritatem facilius imitari. Ista tamen omnia quæ aut fortuite aut astute vera dicunt, præ cæteris quæ mentiuntur, pars ea non est millesima.* And a little after, *Idem* Favorinus *deterrere volens ac depellere adolescentes a Genethliacis istis, & quibusdam alijs id genus, qui prodigiosis artibus futura omnia dicturos se pollicentur, nullo pacto adeundos esse consulendosq; hujusmodi argumentis concludebat, Aut adversa (inquit) eventura dicunt, aut prospera: si dicunt prospera, & fallunt; miser fies frustra expectando: si adversa dicunt, & mentiuntur: miser fies frustra timendo sin vera respondent, eaq; sunt non prospera; jam inde ex animo miser fies antequam è fato fias: si felicia promittunt, eaq; eventura sunt, tum plane duo erunt incommoda: & expectatio te spe suspensum fatigabit: & futurum gaudij fructum spes tibi jam defloraverit; nullo igitur pacto utendum est istiusmodi hominibus res futuras præsagientibus.*

Chap. LV.

To find the Angles of the Aſcendent, *or the Angle of the* Ecliptique *with the* Horizon, *and the* Altitude *of the* Nonageſimus gradus, *at any time.*

IN the Equinoctial Projection ſet the Suns place to the time propoſed, and get the Altitude of *Culmen Cæli*, by Chapter 46. Then, if the Eaſtern arch of the Ecliptique be ſhorter then the Weſtern, you ſhall count the degrees between the Aſcendent and Mid-heaven; otherwiſe count from the Deſcendent to Mid-heaven. Number theſe degrees on the *Label* from the Center, and where they end make a prick; which prick if you put upon the Parallel of the Altitude of *Culmen Cæli*, you ſhall have in the *Limb*, between the *Finitor* and the *Label*, the meaſure of the leſſer angle, which taken out of 180 degrees leaveth the greater angle. This is done by Probleme 2. Rectang. And note that the leſſer angle, and the Altitude of the *Nonageſimus gradus* be alwayes equal.

Example. *March* 29. 1652. 10. hours 32. minutes *a. m.* ♓ 25 ½ was in *Culmine*: the Meridian Altitude thereof is 36. Between *Culmen* and the Deſcendent I find 61 ½, therefore I prick the degree 61 ½ from the Center in the *Label*; and when I have turned that prick to the 36. *Almicantar*, the *Label* ſhewes in the *Limb* of the *Reet* 42 degrees for the leſſer angle of the *Ecliptique* with the Horizon (exactly 41. 58 minutes) which alſo is the Altitude of the *Nonageſimus gradus*: the greater angle is 138 degrees 2 minutes.

Another way. In the Equinoctial Projection lay the *Label* on the *Nonageſimus gradus*, and obſerve his Declination on the *Label*, and his Horary diſtance from the Meridian. Then in the Meridional Projection and his firſt mode, obſerve where that Declination and Horary diſtance meet on the *Mater*, and the *Almicantar* touching the ſame point ſheweth the Altitude of *Nonageſimus gradus*, which is equal to the angle ſought.

Example. In the former Caſe, where ♓ 25 ½ was in our Meridian, ♈ 24. was *Nonageſimus gradus*; the *Label* laid to it ſhewed me his Declination 9 ½ almoſt, North: and his Horary diſtance

distance from the Meridian in the *Limb* 26. 20 minutes. then the *Finitor* being set to the Latitude, I seek the Intersection of the $9\frac{1}{2}$ Parallel of North Declination with the $26\frac{1}{3}$ Meridian from the *Limb*: and there toucheth the 42 *Almicantar*; shewing the Altitude of *Nonagesimus gradus*, and the quantity of the lesser angle sought, as before. And there cometh unasked also, the $36\frac{1}{3}$ *Azimuth* being the *Azimuth* of the *Nonagesimus gradus*, which is alwayes equal to the Amplitude of the Ascendent. Other wayes, See Chapter 56. and 57.

CHAP. LVI.

The Ascendent *and his* Amplitude, *and the* Altitude *of* Culmen Cæli *given; so to represent the* Ecliptique, *that you may presently find not onely the* Altitude *of the* Nonagesimus gradus, *but the* Altitude *and* Azimuth *of every degree of the* Ecliptique *at one view.*

SEt your Planisphear in the third Mode of the Meridional Projection: that is, If the Ascendent be a North Signe, move the *Finitor* from *Meridies* toward the North Pole, till the North Pole be elevated above the *Finitor* according to the elevation of *Culmen Cæli*; but if the Ascendent be a South Signe, move the other end of the *Finitor* from *Septentrio* toward the North Pole, till the Pole have the Elevation of *Culmen Cæli*. Then number the Amplitude of the Ascendent upon the *Finitor* from the Center to your left hand, (toward *Septentrio*) and take the Meridian that crosseth there for the Eastern arch of the *Ecliptique*, and his match so much distant from the Axtree towards *Meridies* shall be the Western arch; so do the *Azimuths* and *Almicantars* of the *Reet* shew at once the Altitude and *Azimuth* of every degree of the *Ecliptique*.

Example, *March* 29. 1652. 10. hours 32 min. *a m.* I found ♓ $25\frac{1}{2}$ Culminating and his Meridian Altitude (by Chapter 46) 36 degrees, the Ascendent ♋ 24. (by Chapter 47.) and his Amplitude $36\frac{1}{3}$ (by Chapter 15, and 16.) the Sun being then *Eclipsed* in ♈ 19. 11 minutes. I would know his Altitude and

Azimuth, and likewiſe the Altitude and *Azimuth* of the *Nonageſimus gradus*. To this purpoſe, I take the North Pole for *Culmen*, and ſet the *Finitor* 36. below him toward *Meridies*; and from the Center toward my left hand, I number on the *Finitor* the Amplitude of the Aſcendent $36\frac{1}{3}$, there cuts the twenty third Meridian from the Axis: (which here ſerveth for the Eaſtern arch of the *Ecliptique*:) the degree in this *Ecliptique* here cut by the *Finitor* is the Aſcendent ♋ 24. thence I number in this *Ecliptique* South-ward 90 degrees by help of the Parallels, and ſo I come to ♈ 24 degrees, being the *Nonageſimus gradus*. Here the 42 Almicantar toucheth the *Nonageſimus gradus*, ſhewing the Altitude thereof, and here alſo cutteth the *Azimuth* of the *Nonageſimus gradus* $36\frac{1}{3}$ equal to the Amplitude of the Aſcendent, as it is alwayes and ought to be; ſo as that you might have found the *Nonageſimus gradus* by this *Azimuth* with leſs numbring. Now for the Sun, he is in ♈ 19. 11 minutes, that is, nearer the Meridian then the *Nonageſimus gradus* by almoſt 5. degrees: I count therefore 4. 49 minutes (for ſo it is) paſt the *Nonageſimus gradus*; there is the Sun, and the *Almicantar* cutting there ſhewes his Altitude $41\frac{2}{3}$, and his *Azimuth* is ſhewn by the 29 *Azimuth* ſome what near. Or if you would reckon after the order of the Signes, which is eaſier, begin at the Deſcendent, where is ♎ 24. thence $61\frac{1}{2}$ makes ♐ $25\frac{1}{2}$ at the Pole, for *Culmen Cali*: thence in the Eaſtern arch to the Suns place I make 85 degrees 11 minutes; and 4. 49 minutes further is ♈ 24. the *Nonageſimus gradus*.

CHAP. LVII.

To do the ſame another way, by the Horizontal Projection, *very plainly.*

TAke the *Zenith* for the Aſcendent, and ſet him in his place in the *Limb* (which here is Horizon) ſo much from *Oriens* as his Amplitude comes to; and that toward *Septentrio*, if it be a Northern Signe, or if it be a Southern Signe toward *Meridies*. Then number upon the Meridian line from the *Limb* inwards the Altitude of *Culmen Cali*, and the *Azimuth* that cutteth there ſhall be your *Ecliptique* in this Caſe: If the *Azimuths* reach not the Meridian, turn

turn about the *Reet*, and ſet Nadir for Aſcendent. Lay the *Label* to any degree of this *Ecliptique*, and the degrees of the *Label* from that degree to the *Limb* ſhall be the Altitude thereof: and between the *Label* and *Meridies* in the *Limb* the *Azimuth* thereof.

Example. Becauſe in the Caſe of the former Chapter I foreſee that the Sun will be paſt the *Nonageſimus gradus*, and ſo in the Weſt Quadrant of the *Ecliptique* (though he be in the Eaſt Quadrant of the Horizon) therefore I ſet *Nadir* at the Amplitude of the Aſcendent *viz.* 36 $\frac{1}{3}$ from *Oriens* North-ward, then in the Meridian line I number from the *Limb* inwards 36. for the Altitude of *Culmen*, where I make a prick, and ſay, Here is ♐ 25 $\frac{1}{2}$ Culminating, and through that prick paſſeth the 42. *Azimuth* from the *Limb*, which is now my *Ecliptique*; and by that I ſee that the angle of the *Ecliptique* which the Horizon (called the angle of the Aſcendent, and alwayes equal to the Altitude of *Nonageſimus gradus*, as was ſaid) is 42 degrees: and if I follow this *Azimuth* to the *Finitor*, there is *Nonageſimus gradus*, and the Altitude thereof 42 degrees counted from the *Limb* (here Horizon) the *Azimuth* thereof lies in the *Limb* between the *Finitor* and the Meridian 36 $\frac{1}{3}$ as before, equal to the Amplitude of the Aſcendent, I number alſo from ♐ 25 $\frac{1}{2}$ in the Meridian 23. 41 minutes to the left hand ſtill, and there I have ♈ 19. 11 minutes, the Suns place, which cuts on the *Label* 41 $\frac{2}{3}$. for the Altitude of the Sun there, and the *Label* at the ſame time cutteth in the *Limb* about 29. from South Eaſt-ward for the *Azimuth* of the Sun: and after the ſame manner you have before you the Altitude and *Azimuth* of every other degree of the *Ecliptique* for the time propoſed.

Chap. LVIII.

To do the ſame by the Nonageſimal Projection, *if the* Altitude *of* Nonageſimus gradus *be firſt given inſtead of the* Altitude *of* Culmen Cæli.

SEt your Planiſphear in the *Nonageſimal Projection* (by Book 2. 3.) that is, make the *Limb* now to repreſent the Circle of Longitude or *Azimuth* (for it is both) which cutteth

cutteth the *Nonageſimus gradus*, and make the Equinoctial line here to be Horizon: and from the Equinoctial line number in the *Limb* the Altitude of *Nonageſimus gradus*, and thereto ſet the *Finitor*, ſo ſhall the *Finitor* be *Ecliptique*, the *Nonageſimus gradus* at the *Limb*, the Aſcendent and Deſcendent at the Center: and becauſe the Equinoctial line is Horizon in this Projection, therefore the Meridians become *Azimuths*, and the Parallels *Almicantars*, ſhewing the Altitude and *Azimuth* of every degree of the *Ecliptique*, if you reckon as you ought in this manner. Reckon in the Equinoctial line (here Horizon) from the Center the Amplitude of the Aſcendent, to the right Hand, if it be a North Signe, and contrarily if it be a South Signe. Where this Amplitude ends is the Eaſt point, from whence you ſhall reckon all your *Azimuths*. Count thence to the *Limb* and back again (if need be) in the ſaid Equinoctial line, till you have made 90 degrees, there is your Meridian, as far diſtant from the *Limb*, as the Eaſt point was from the Aſcendent. Follow this Meridian to the *Finitor*, and there he ſhewes you *Culmen Cæli*, and the Parallel there cutting ſhewes the Altitude thereof. Now may you find every degree of the *Ecliptique* above the Horizon, if you know but what Aſcends, or Deſcends, or Culminates; and of every ſuch degree the Parallels ſhew you the Altitude, and the Meridians ſhew his *Azimuth*, if you begin your numbring from the Eaſt or South *Azimuth*.

Example. When ♋ 24 degrees was Aſcending (as in the Example before uſed) as by conſequence ♈ 24. in *Nonageſimo gradu*, ♂ was in ♉ 4. 45 minutes, and had but 3. or 4. minutes South Latitude: I would know ♂ his Altitude, and *Azimuth*, ſetting go the *Finitor* above the Equinoctial line 42 degrees (which is the Altitude of *Nonageſimus gradus*) I ſay, becauſe the *Nonageſimus gradus* at the end of the *Finitor* in the *Limb*, is ♈ 24. therefore I muſt count back 10. 45 minutes toward the Aſcendent for *Mars*, and there the Parallel 41 degrees with 10 minutes cutteth the *Finitor*, for the Altitude of ♂, and the 14th. Meridian Eaſt-ward from the *Limb* gives me his *Azimuth*, which if I begin to reckon from the Eaſt point, falleth out to be almoſt the 40th. *Azimuth* from the Eaſt. *Mars* his Latitude here is not regarded.

CHAP.

CHAP. LIX.

The Nonageſimus gradus, *and his* Altitude *and* Azimuth *given, as in the former Chapter. How in the ſame Projection to get the* Altitude *and* Azimuth *of any Planet or Star, by his* Longitude *and* Latitude.

YOur Palniſphear ſet as in the former Chapter: you ſhall number the Longitude of the Star upon the *Finitor*, (here *Ecliptique*) beginning at the Deſcendent or *Nonageſimus gardus*; and in the *Azimuth* ſerving his Longitude, count his Latitude by the *Almicantars*, at the end of which account is the Stars place for this time. The Parallel cutting there ſhewes his Altitude, and the Meridian cutting there ſhewes his *Azimuth*, if you count from the Eaſt point as you were taught in the former Chapter.

Example. *Lucida Pleiadum* was in Longitude ♉ 25. 10 minutes, Latitude 4 degrees 00 minutes North. Therefore from the *Nonageſimus gradus* ♈ 24. I number in the *Finitor* toward the Aſcendent 31. 10 minutes, and there is the Longitude of *Lucida Pleiadum*; in the *Azimuth* that cuts here I go up Northward 4 degrees, and there I make a prick for *Lucida Pleiadum*. Now the Parallel 38 ½ ſhewes me his Altitude, and the 48th ½. Meridian from the Center, ſhewes me that *Lucida Pleiadum* is gone 48 ½ in *Azimuth* from the Aſcendent, but from the Eaſt point onely 12 degrees 10 minutes.

CHAP. LX.

The Altitude *and* Azimuth *of any Star taken, and either the* Aſcendent, Nonageſimus gradus, *or* Culmen Cæli *known: How by the ſame* Nonageſimal Projection *to find the Stars* Longitude *and* Latitude.

IF you know either the *Aſcendent*, *Nonageſimus gradus*, or *Culmen Cæli*, you have enough to put your Planiſphear in the *Nonageſimal Projection*, by the former Chapters. And your Planiſphear ſo ſet, you ſhall ſeek out the Meridian,

which ſtandeth for the *Azimuth* in which you obſerve the Star; and therein number from the Equinoctial line the Altitude obſerved: the *Azimuth* and *Almicantar* cutting there ſhew the Longitude and Latitude of the Star inquired. If the *Azimuths* reach not the place of the Star, turn the *Reet* half round, and let the *Zenith* and *Nadir* points change places; and your turn is ſerved.

Example. *Febr.* 13. $165\frac{7}{8}$. I obſerved (ſomewhat near) that ♅ was gone Weſt-ward from the Meridian in *Azimuth* 14 degrees, and that his Altitude was 61 degrees; *Sirius* was then in the Meridian, by which I have the *Aſcendent*, *Culmen*, and *Nonageſimus gradus*, any or all of them given. For when in the Equinoctial Projection I bring *Sirius* to the Meridian line, it is all one as if I had ſet the Suns place to the hour of the Night (by Chapter 46.) and I ſee there Culminates with *Sirius* ♋ 7. 10 minutes, whoſe Meridian Altitude (by the 46.) is 61. 5 minutes; and I ſee ♎ $5\frac{1}{2}$ aſcending in my Horizon, and ♈ $5\frac{1}{2}$ deſcending; therefore ♋ $5\frac{1}{2}$ is *Nonageſimus gradus*, which is 90 degrees diſtant both from the Aſcendent and Deſcendent: his Altitude (by Chapter 55.) 61. 10 minutes almoſt. Therefore I ſet the *Finitor* 61. 10 minutes above *Meridies*, (as Chapter 58.) and in the *Finitor* at the *Limb* I count ♋ $5\frac{1}{2}$ *Nonageſimus gradus*; thence I go inwards in the *Finitor* 1. 40 minutes where I come to ♋ 7. 10. the degree of Culmination; this degree is cut by the 4th. Meridian from the *Limb*, whereby I learn that this 4th Meridian will be the Meridian of my place, and that the Amplitude of the *Nonageſimus gradus*, and likewiſe of the Aſcendent, is 4 degrees. Now to place ♅ in the *Mater*, I count his *Azimuth* firſt, beginning from the Meridian of my Place now found. Firſt I reckon up from the *Culmen Cæli* to *Nonageſimus gradus* in the *Limb* 4 degrees, (for ſo much the *Nonageſimus gradus* is Weſt of the Meridian) and thence back again, I tell to the 10th. Meridian from the *Limb*, which maketh the 14th. *Azimuth* from *Medium Cæli*, in which *Azimuth* I obſerved *Jupiter* in that Meridian; (uſed here for the 14th. *Azimuth*) I reckon the Altitude of *Jupiter* from the Equinoctial line, 61 degrees, and at that Altitude I make therein a prick for the place of ♅: And immediately I ſee this prick ſtandeth a quarter of a degree above the *Finitor*, ſhewing the Latitude of ♅ 15 minutes North, and it is cut by almoſt the 5th. *Azimuth* from the *Limb*, which ſheweth me that the

the Longitude of ♃ is 4. 50 minutes leſs then the Longitude of *Nonageſimus gradus*; and therefore that ♃ is in ♋ 0, 40 minutes.

CHAP. LXI.

The Latitude *and* Azimuth *of a Star, and either the* Aſcendent, Nonageſimus gradus, *or the* Culmination *given, to find his* Longitude.

YOur Planiſphear being ſet in the *Nonageſimal Projection*, (as in the former Chapter) ſeek the Meridian that ſerveth for the *Azimuth* of the *Star*, and mark where it cutteth the *Almicantar* ſerving for the Parallel of the *Stars* Latitude. The *Azimuth* cutting there ſhewes the Longitude, which you ſhall reckon from the *Aſcendent*, or *Deſcendent*, or *Nonageſimus gradus*; whoſe Longitudes are known, as was ſhewed in the former Chapter.

Example. Suppoſe ♃ his *Azimuth* obſerved 14 degrees from South Weſtward (as Chapter 60.) and ſuppoſe his Latitude known 15 minutes North: (Though I know the Tables make *Jupiters* Latitude here divers minutes leſs, that matters nót to our purpoſe here) I ſay where the 10th Meridian (which by the former Chapter is the 14. *Azimuth* in this poſture of my Planiſphear) cutteth the *Almicantar* 0 $\frac{1}{4}$ ſerving for *Jupiters* Latitude, there cutteth an *Azimuth* which gives me *Jupiters* Longitude, as in the former Chapter.

CHAP. LXII.

To find the Parallactical Angle; *that is, what* Angle *the* Azimuth *maketh with any point of the Ecliptique, by the* Altitude *of that point, and of the* Nonageſimus gradus.

NUmber on the Label from the Center the Complement of the Altitude of the point propoſed, (which may be known by Chapter 56.) and at the end of it make a prick, and having (by Chapter 55. or otherwiſe) the

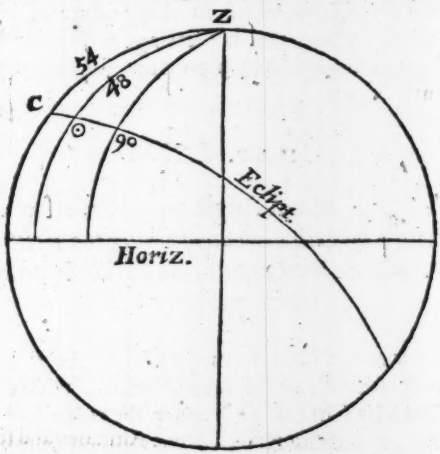
Altitude of *Nonageſimus gradus*, turn the prick you made on the *Label* to touch the *Almicantar*, which is Complement of that Altitude: then in the *Limb* of the *Reet* between the *Finitor* and the *Label* is the quantity of the angle.

Example. In Chapter 56. the Altitude of the Sun in the middle of the *Eclipſe* which hapned *March* 29. 1652. 10. hours 32 minutes *a. m.* was 41. 47 minutes, and the Altitude of *Nonageſimus gradus* 41. 58 minutes; wherefore I make a prick on the edge of the *Label* at 41 $\frac{3}{4}$ counted from the *Limb*, (or I count the Complement hereof from the Center, and make the prick) and having turned that prick to the fourty ſecond *Almicantar* from the *Zenith*, I find the *Label* ſhewing 87 degrees in the *Limb* of the *Reet*, the quantity of the angle.

But becauſe the *Label* here cutteth the *Almicantar* ſo ſlope that you can hardly obſerve the juſt point of Interſection, I will ſhew you another way.

The Complement of the Altitude of *Culmen Cæli*, the diſtance of the point propoſed from *Culmen*, and the Complement of Altitude of the ſaid point, make a Triangle; whoſe 3 ſides are all known, or may be known by the Chapters foregoing: Therefore by the firſt Probleme of Obliquangled Triangles you may find the angle.

Example. I ſet the Complement of the Suns Altitude Z ⊙



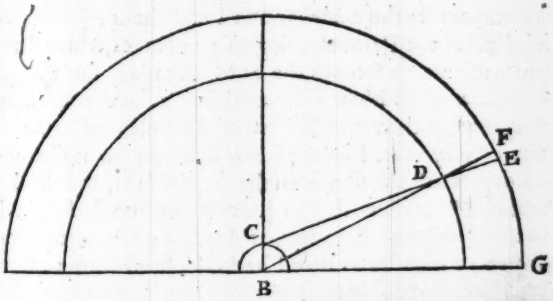
for

for A B in the *Limb*, and marking where the 54th Parallel, counted from the Pole meets with the *Almicantar* 23. 41 minutes, (counted from the *Zenith*,) there I find the *Azimuth* 93. 19 minutes, shewing the greater angle at the Sun, whose *Supplement* 86. 41 minutes is the lesser angle sought; and this lesser angle below the *Ecliptique* is alwayes Westward in the West Quadrant, and contrary in the East. In the first way you resolve the Rectangled Triangle Z. 90. ⊙, by the Probleme 2. Rectang. and third Variety: in the second way you resolve the Oblique Triangle Z ⊙ C by Probleme 1. of Obliqueangled Triangles.

CHAP. LXIII.

To find the Parallax *of* Altitude *of the* Sun, *or* Moon.

THe true Altitude of the Sun, or Moon, ought to be observed in the Center of the Earth, whereto the Tables are conformed: but because we dwell upon the Superficies of the Earth almost 4000 English miles from the Center, therefore the Planets seem lower to us then indeed they be. *Suppose* a Man observed the apparent Altitude of the Moon at C on the Superficies of the Earth to be E G 10 degrees; he that could observe it in the Center at B might find the



true Altitude F G almost 11 degrees. Now the smal angle at D (being equal to the difference of these Altitudes, and subtended on

this ſide by the Semidiameter of the Earth B C, and on the further ſide by the arch of the difference of theſe Altitudes in the *Primum mobile*,) is called the angle of the Parallax of Altitude. This Parallax is greateſt in the Horizon, and decreaſeth as the Planet riſeth higher, till in the *Zenith* it vaniſh into nothing: becauſe there the line drawn from the Center falls into the line drawn from the Superficies of the Earth to the Planet, and makes therewith no angle at all.

To get the Parallax for any Altitude propoſed, you muſt firſt get the Horizontall Parallax out of ſome Aſtronomical Tables: for it varyes according to the Planets diſtance from the Earth; which is not alwayes the ſame; yet the Suns Horizontal Parallax you may alwayes reckon to be about 3 minutes, and the Moons Horizontal Parallax to be at the leaſt 50 minutes, and at the moſt 68 minutes. This had, I number the Horizontal Parallax in the *Limb* from the Equinoctial line, and thereto lay the *Label*; and number the Altitude of the Planet on the *Label* from the *Limb*, and the Parallel that cuts that Altitude ſhewes the Parallax deſired. And note here, that for every minute of the Horizontal Parallax you may reckon 5, 10, or 20, times ſo many, ſo that your *Label* riſe not beyond 10 degrees in the *Limb*; ſo ſhall you attain the minutes more exactly.

Example. *March* 29. 1652. the Altitude of the *Sun* in the middle of the Eclipſe was 41. 47 minutes, and his Horizontal Parallax according to *Lantsbergius*, 2 minutes 18 ſeconds, for which I number 2 degrees 18 minutes from the Equinoctial line, and thereto ſet the *Label*; and ſo I find the 43 $\frac{3}{4}$ degrees of the *Label* to cut the Parallel 1 degree 30 minutes, which I am to accompt 1 minute 30 ſeconds, the Suns Parallax for this Altitude. Likewiſe the Moons Horizontal Parallax according to *Lantsbergius*, was then 62 minutes, her Altitude the ſame with the *Suns*, or very near; I ſet the *Label* therefore to make an angle of 6 degrees 12 minutes with the Equinoctial, and ſo I find the Parallel 4 $\frac{2}{3}$ cutting the 41 $\frac{3}{4}$ degree of the *Label*; which ſhewes the Parallax of the ☽ in that Altitude 46 $\frac{1}{2}$, accounting every degree 10 minutes, as here I had appointed them to ſignifie.

CHAP.

CHAP. LXIV.

The Parallactique Angle, *and the* Parallax *of* Altitude *given, to find the* Parallax *of* Longitude *and* Latitude.

IF the *Azimuth* or Circle of Altitude make no angle with the *Ecliptique*, but be co-incident with it (as where the *Ecliptique* cuts the *Zenith*) then doth the Parallax of Altitude vary the Longitude only; and ſo much as the *P*arallax of Altitude is, ſo much is the apparent Longitude of the *P*lanet greater then the true Longitude in the Eaſtern Quadrant of the *Ecliptique*, and ſo much leſſer in the Weſtern.

If the *Azimuth* make a Right angle with the *Ecliptique* (which it may do only in *Nonageſimo gradu*) then doth the Parallax of Altitude vary the Latitude onely; and ſo much as the Parallax of Altitude is, ſo much muſt be added to the apparent North Latitude, or ſubducted from the apparent *S*outh Latitude, to make the true Latitude of the Planet North or South. If the *Azimuth* cut the *Ecliptique* with Oblique angles (as moſt commonly it hapneth to do) then doth the Parallax of Altitude vary both the Longitude and Latitude. And the nearer the Planet is to the *Nonageſimus gradus*, the greater is the Parallax of Latitude, and the Parallax of Longitude leſs: and contrarily the further the Planet is from *Nonageſimus gradus*, the greater is the Parallax of Longitude, and the Parallax of Latitude the leſs.

The Parallax of Altitude is alwayes the *Hypotenuſa*, and the Parallax of Longitude and Latitude are the legs of a ſmal Rect-angled *S*pherical Triangle, which may be called the Parallactical Triangle, and the leg which hath the Parallax of Longitude is a ſegment of the *Ecliptique*, or of a Parallel near it, and the leg which hath the Parallax of Latitude, is a ſegment of a Circle of Longitude paſſing through the apparent place of the Planet, and through the Poles of the *Ecliptique*, and cutting the *Ecliptique*, or his ſaid Parallel at Right angles, as in the Figure. *The Parallactical Triangle.*

C is the apparent place of the Planet.

B is his true place, in which he muſt be ſeen from the Center.

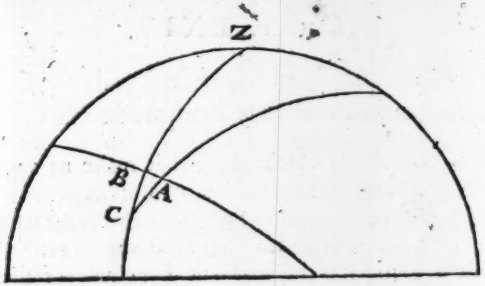
A B C is the Parallactique angle.

B C is the Parallax of Altitude.

B A the Parallax of Longitude.

C A the Parallax of Latitude.

Where-



Wherefore by the third Probleme of Rectangled Triangles, Book 3. 5. you may presently get both the legs.

Example. The Parallactical angle B, was found Chapter 62. to be 86. 41 minutes, and the Parallax of the Moons Altitude, (Chapter 63.) to be 46 $\frac{1}{2}$ minutes for the same time. Here therefore having laid the *Label* to 86. 41 minutes from the Equinoctial, I number in the *Label* from the Center 46 degrees and an half (in stead of 46 minutes and an half the Parallax of Altitude) and I find that the 46 $\frac{1}{3}$ Parallel cutteth the said 46 $\frac{1}{2}$ degree of the *Label*; by which I know that the Leg C A for the Parallax of Latitude is 46 $\frac{1}{3}$ very near, (for the ☽ here being near the *Nonagesimus gradus* all her Parallax almost goes into Longitude,) but B A of my Triangle is covered by the head of my *Label*. Nevertheless I may see his measure in any of the Parallels to be 3 $\frac{1}{2}$ minutes for the Parallax of Longitude, for it is the 3 $\frac{1}{2}$ Meridian from the Axis, which cutteth 46 $\frac{1}{2}$ of the *Label:* and if I had not this shift, I might have my choice of other shifts, shewed Book 3. the 8, 9, 10, 11, 12, and 13th. Chapters.

The Suns Parallax of Altitude Chapter 63 for the same time was found 1 minute $\frac{1}{2}$. therefore laying the *Label* to the Parallactique angle (as before) I number on the *Label* for the side B C (the Suns Parallax of Altitude, being 1 minute $\frac{1}{2}$) 9 degrees, so every degree here signifieth 10 seconds; and I find there cutting almost the 9th Parallel, shewing me that C A the Parallax of the Suns Latitude is 1 $\frac{1}{2}$ minute almost (that is almost as much as his Parallax of Altitude) and there cutteth also the Meridian 0 $\frac{2}{3}$, shewing me that the side B A, Parallax of Longitude, is almost 7 seconds.

The

The Sun therefore (though he never have Latitude) by reason of his Parallax, appeared in the middle of this Eclipse to have *South* Latitude $1\frac{1}{2}$ minute, the Moons true Latitude was then by *Lantsbergius* his Tables 45 minutes, 24 seconds North; so that by this accompt the Sun and Moons Centers were distant in Latitude 46 minutes, 54 seconds: but when out of this distance you have subtracted $46\frac{1}{3}$ for the Moons Parallax of Latitude, there remains 34 seconds for the apparent distance of the Centers of the Sun and Moon. But by Observation, I found them distant 1 minute 48 seconds: for the digits Eclipsed at *Eclon*, were 11. $22\frac{1}{2}$ minutes; and so perhaps might I have found by my Planisphear, or some what near, had it been large enough, and had I regarded every minute and second precisely in setting down this Example, which were more then needed for my purpose in this place.

Chap. LXV.

To find the Moons Latitude, *by her distance from either of the* Nodi, *called* Caput, *and* Caudi Draconis.

As the *Ecliptique* crosseth the Equator with an angle of 23. 30 minutes for our Age, so the *Orbite* or Circle in which the Moon moveth crosseth the *Ecliptique*: but the angle of Inclination is not alwaies nor long the same: for in the *Conjunctions* of the Sun and Moon the angle is ever 5 00 minutes, and increaseth to the time of the Quadrature, when it is found 5 degrees 16 minutes; thence it decreaseth to the *Opposition*, where it is again but 5 degrees, as in the *Conjunction*; thence it increaseth again to 5 degrees 16 minutes in the latter □, and again thence decreaseth to 5 degrees in the ☌.

Get by the *Astronomical* Tables the quantity of the angle made between the *Ecliptique* and the *Orbite* of the Moon, (which in all *Conjunctions* and *Oppositions*, and therefore in all Eclipses is 5 degrees, as was now said) and get also by the like Tables the Moons distance from the nearest of the *Nodes:* then may you find the Moons Latitude, by the Probleme 3. Rectangled Triangles, Book 3. 5. just as you use to find the Suns Declination, by his Longitude and greatest Declination.

Example. The ☽ in the former Case was distant from *Caput Draconis* by *Lantsbergius* Tables 8 degrees 43 minutes. I lay

the *Label* from the Equinoctial line to 5 degrees in the *Limb*, and counting in the *Label* from the Center 8, 43. I ſee there the Parallel of $0\frac{3}{4}$ (that is, 45 minutes, or 46 minutes) croſſing for the Moons Latitude.

CHAP. LXVI.

To find the Dominical Letter, *the* Prime, Epact, Eaſter day, *and the reſt of the moveable* Feaſts *for ever, by the Calender, diſcribed Book* 1. 11.

AN Example, ſhall ſerve here inſtead of a Rule. For the Year 1657. I would know all theſe: wherefore I ſeek the Year 1657. in the Table of the Suns *Cycle*, and over againſt it, I find 14. for the Year of the *Cycle* of the Sun, and D for the *Dominical Letter*. And note here, that every *Leap-year* hath 2 *Dominical Letters* (as 1660. hath A G) and the firſt (*viz.* A) ſerveth that Year till *February* 25, and the ſecond (G) for the reſt of the Year. And note that theſe letters go alwayes backwards when you count forwards (as B A, then G F, &c. not F G, and then A B) as you may ſee by the Table.

Then in the Table of the *Cycle* of the Moon, I have for the Year 1657. the *Prime* 5. the *Epact* 25. Thoſe had, I go to the Table for *Eaſter*, and ſeek there in the firſt rank the *Prime* 5. and under it in the middle rank ſtands E; that is not my *Dominical Letter*; therefore I ſeek not backward, but alwayes forward in the middle rank, till I come to my *Dominical Letter* D. and under it I find in the third rank *March* 29. upon which *Eaſter* day falls this Year 1657. The reſt of the moveable *Feaſts* may be had by their diſtances from *Eaſter*, which are alwayes the ſame. Onely for *Advent Sunday*, remember that the next Sunday after *November* 26 is *Advent Sunday*. Read Book 1. 11. and that will ſufficiently inſtruct you with this Example.

CHAP. LXVII.

To find the age of the Moon, *by the* Epact.

REmember firſt that the *Epact* begins with *March*, which muſt be here accounted the firſt Moneth: Then if you add

add to the *Epact* the number of the Moneth current, and the number of the day of the Moneth current, the ſum or the excels above 30. is the Moons age.

Example. *January* 20. 1656. According to the accompt of the Church of *England*, (who begin the Year with *March* 25. which was the Equinoctial day about Chriſt time) the *Epact* is 14. *January* is the 11th Moneth, and the 20th day is propoſed; now add 14, 11, and 20. together, they make 45. out of which I take 30. and there remains 15. the Moons age.

This Rule is of good uſe, not onely to find the age of the Moon, and ſo her changes to a day, but alſo for examining of *Chronologie*, where the time is moſt certainly reckoned by Eclipſes. But you muſt note, that if you apply this Rule to the Years paſt before *Anno Dom.* 1600. then for every 312. Years that the Year propoſed precedes *Anno Dom.* 1600. you muſt ſubtract one day out of the age of the Moon, found by this Rule.

Example. *Tacius lib.* 1. Reports, That in the beginning of *Tiberius Cæſar's* reigne there was an Eclipſe of the Moon, and *Temporarius* ſaith, that whereas *Auguſtus* died *Aug.* 29. (I think he ſhould ſay 19.) this Eclipſe hapned *Sep.* 27. I would know whether it were poſſible for an Eclipſe to happen that day, ſuppoſing the beginning of *Tiberius* to be in *Auguſt*, *Anno Dom.* 14. and *Anno Periodi Julianæ* 4727. The *Prime* for that Year is 15, and the *Epact* 15. by Book 1. 11. add now to the *Epact*, for *September* 7. and for the day of the Moneth 27. and the ſum is 49. out of which ſubducting 30. I leave the Moons age 19. but becauſe *Anno Dom.* 14. precedes *Anno Dom.* 1600. 5. times 312. Years, therefore out of 19 I ſubduct 5. and there remaines 14. the age of the Moon, corrected for *September* 27. *Anno Dom.* 14. Therefore it was about the full Moon: and it is poſſible the Moon might be Eclipſed then, as *Temporarius* ſaith. But it could not be Eclipſed *September* 27. *Anno Dom.* 13, for then the *Epact* being 4. the age of the Moon by the ſame Rule was 3. neither could it happen *Sep.* 27. *Anno Dom.* 15. for then by the ſame Rule the age of the Moon, was 25. at what age the Moon was far from her oppoſition to the Sun: and therefore could not be Eclipſed.

Chap. LXVIII.

To find in what Parallel *and* Climate *a Place is, by the* Latitude *given.*

Parallels in *Geography* are leſſer Circles Parallel to the Equator, and paſſing through the *Zenith* of a Place, and ſucceeding one another at ſuch diſtance that at every Parallel the length of the day is varyed a quarter of an hour.

A *Climate* is ſuch a Parallel as altereth the length of the day half an hour. The Parallels and Climates begin from the Equator, under which the day is alwayes equal to the Night, and each 12 hours long: hence they count the Parallels and Climates Northward, and Southward: but becauſe the Earth was not ſo far known to *Ptolomy* and the Ancient *Geographers*, as it hath been to thoſe of later Times, therefore there is great difference between the Ancient and later *Geographers* about the number and quantity of the ſpaces contained by them: as among others *Kerkerman Syſt. Geography, lib.* 1. hath ſhewed.

Yet may they eaſily be found to every Mans mind, by the Planiſphear in the Meridional Projection, thus. Find by 4. 17. what is the *Semi-diurnal* arch of the Sun in ♋, out of which, take 6 hours, and look how many quarters of an hour the double of the reſidue containeth, ſo many *Geographical Parallels* is the place removed from the Equator, and half ſo many Climates.

Example. I find the *Semi-diurnal* arch in our Latitude to be 8 hours 16 minutes, in the *Tropique* of *Cancer*; out of which taking 6. and doubling the reſidue, I have 4. 33. which is more then 9 half hours, or more then 18. quarters: ſo much our longeſt day exceeds 12 hours; therefore we ſhould be paſt the 18th Parallel, and 9th Climate, *viz.* in the beginning of the 10th Climate, and 19th Parallel.

Chap.

CHAP. LXIX.

The Longitude *and* Latitude *of two Places given, to find their* Diſtance.

WHat Longitude and Latitude in *Geography* are, and how they differ from Longitude and Latitude in *Aſtronomy*, hath been ſhewed, Book 4. 5. 11.

If the places differ only in Latitude, and have one Longitude, bearing full North or South one from another; then take their difference of Latitude, by ſubducting the leſs out of the greater, if the places have both North Latitude, or both South Latitude: or take the ſum of their Latitude, if one be North, and the other South. Then for every degree of this difference or aggregate number, you may reckon 69 ½ Engliſh miles of the Statute, which ordaineth 1760. Yards to be a Mile: but of Engliſh Miles meaſured by common eſtimation, there go not above 60. to a degree; ſo that every ſuch Mile that you Travel North or South ſhall alter your Latitude about one minute. If they differ in Longitude onely, and have no Latitude, but be both under the Equator, you ſhall reckon in like manner for every degree they differ in Longitude 69 ½ Miles of diſtance.

In all other Caſes you have a Triangle ſoluble by the ſecond Probleme of Obliquangled Triangles: of which Triangle the Complements of Latitude make the two comprehending ſides, and the difference of the Longitudes of the places is the angle comprehended between them, and the third ſide is the arch of the diſtance of the places; which when you have found in degrees and minutes of a great Circle, you may turn into Miles as before: mark how the diſtance of two Stars is found by their Longitude and Latitude given, Chapter 37. in the ſame manner may you find the diſtance of two Cities or Towns.

Example. I would know the diſtance of *London* from *Jeruſalem*. The Complement of the Latitude of *London* is 38. 28 minutes: the Complement of the Latitude of *Jeruſalem* is 58. 05 minutes: the difference of their Longitudes 46. 0 minutes. I ſet the *Zenith* to the Latitude of *London* in the *Limb*, that is 38. 28 minutes from the Pole, ſo the *Limb* is the Circle of Longitude in which *London* ſtandeth, then I ſeek the 46 Meridian from

that ſide of the *Limb* where *Zenith* is ſet for *London*, for that 46 Méridian is the Circle of *Jeruſalems* Longitude: (becauſe the difference of Longitude is 46.) Now becauſe *Jeruſalems* Latitude is 31. 55. and the Complement thereof, or diſtance from the Pole 58. 5 minutes, I walk on in the 46 Meridian till I come where the 58th Parallel from the Pole croſſeth him, and there is the place of *Jeruſalem*: the *Azimuth* that goes hence to the *Zenith* is the neareſt way from *Jeruſalem* to *London*: what *Azimuth* this is I regard not, for I enquire not the angle at *London*, but I obſerve by the Parallels how many degrees there be in him between the places of *Jeruſalem* and the *Zenith*, and I find 38 degrees 20 minutes: which being reſolved into Miles is 2300. Miles of common eſtimation, but Miles of the Statute 2664. the diſtance of *London* from *Jeruſalem*.

CHAP. LXX.

The Latitude *and* diſtance *of two Places given, to find the difference of* Longitude.

THe Triangle will ſtand as in the former Chapter: there by two ſides and the angle comprehended you ſought the third ſide, by Probleme 2. Obliquangled Triangles: here by three ſides given, you ſeek an angle by Probleme 1 Obliquangled Triangles.

Make the Pole, Pole: and ſet the *Zenith* to the Latitude of one of the places, as you did *London*. (Chapter 69.) 38. 28 minutes from the Pole, then number the Complement of the Latitude of the other place from the Pole, by the Parallels, and the diſtance of the two places from the *Zenith* by the *Almicantars*; and where the laſt Parallel and laſt *Almicantar* meet is C of your Triangle: (ſee Book 3. 14.) Now count how many Meridians there be between C and the *Limb*, ſo many degrees is the angle at the Pole ſought, for the difference of Longitude.

Example. Having the diſtance of *London* from the Pole 38. 28 minutes, and of *Jeruſalem* from the Pole 58. 5 minutes, and the diſtance of *London* from *Jeruſalem* 2300. common Engliſh Miles, (of which 60. make a degree) I ſet the *Zenith* for *London* 38. 28 minutes from the Pole in the *Limb*, then becauſe *Jeruſalem* is diſtant from the Pole 58. 5 minutes, I go to the 58th Parallel

Parallel from the Pole, and lay one finger or the point of a bodkin on him; and becauſe *London* is diſtant from *Jeruſalem* 38 degrees 20 minutes, I count from the *Zenith* to the *Almicantar* 38. 20 minutes; now where this *Almicantar* croſſeth the Parallel laſt found, there is C of the Triangle, and the place of *Jeruſalem*: and you may ſee that you muſt croſs 46. Meridians before you can go thence to the *Zenith* in the *Limb*; which ſheweth that the angle at the Pole for the difference of Longitude is 46.

CHAP. LXXI.

To find what degree of the Ecliptique *Culminates in another Country, at any time propoſed, if the difference of* Longitude *be known.*

IN the Equinoctial Projection, Bring the Suns place to the hour propoſed, by help of the *Label*: and in the Noon-line you ſee preſently what degree Culminates in your Country. (as Chapter 46. is ſhewed.) Now to know this for another Town, ſet the *Label* ſo many degrees from the Noon-line as the difference of Longitude requires, and that Eaſtward, if the place propoſed be Eaſt, or Weſtward if it bear Weſt; and ſo the *Label* ſhall cut the degree of Culmination, for the place propoſed.

Example. If it be demanded what degree is Culminating at *Jeruſalem March* 10. at 10. a clock before noon, I will ſet the Suns place ♈ 0. to the hour; and I ſee upon the Noon line, which is our Meridian, there Culminates ♒ 28 almoſt. Now for the Meridian of *Jeruſalem* I muſt lay the *Label* 46 degrees Eaſtward, that is from *Meridies* towards *Oriens*, and look what Star or degree of the *Ecliptique* is then cut by the *Label*, that is then Culminating in the Meridian at *Jeruſalem*; (as here I find ♈ 17 $\frac{1}{2}$.) for in this Projection the *Label* (lay him where you will) is a Meridian.

CHAP.

CHAP. LXXII.

To find what a Clock it is in another Country, *by knowing the hour at Home, and the difference of* Longitude.

THis is done easily enough without an Instrument: for if you turn the difference of Longitude into hours and minutes, and add the same to your hours for any place which lies Eastward, or subtract the same for any place which lies Westward, you shall make the hour of the place.

Example. The difference of Longitude between *London* and *Jerusalem* is 46. or being converted into time 3 hours 4 minutes: therefore adding this to the time at *London*, I say, when it is noon at *London*, it is 4 minutes past 3 a clock after noon at *Jerusalem*: and when it is 2 a clock at *London*, it is 5. and 4 minutes at *Jerusalem*.

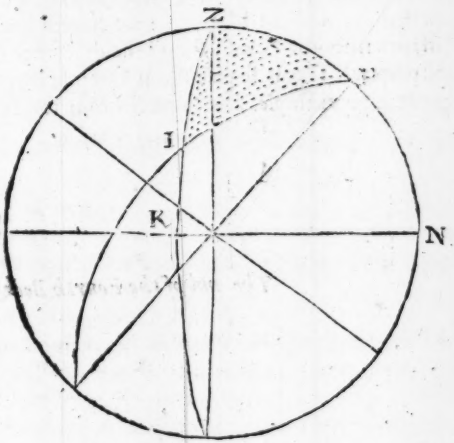
If you will do it by the Planisphear, you shall do it in the Equinoctial Projection, thus. Whereas the *Limb* of your *Reet* is graduated into 360 degrees, if you distinguish the hours also at every 15th degree, beginning at the *Zenith* (which shall be 12) and numbring thence in the *Limb* of your *Reet* to your right hand or Westward, 1, 2, 3, &c. then shall you need to do no more but set the *Zenith* to the difference of Longitude, East or West from your Meridian, as the strange place happeneth to be situate: for then the *Label* laid to the hour of your Country in the Limb of the Mater, shall shew the hour of the other Country in the *Limb* of the *Reet*. And so the *Zenith* being laid to 60 degrees Westward, which is the Meridian of the *Isle* of *Barbados* the *Label* laid to *Meridies* shall cut in the *Limb* of the *Reet* 8 of the clock before noon: which sheweth me that when it is noon with us, it is at *Barbados* but eight in the morning.

The end of the Fourth Book.

CHAP. LXXIII.

The Longitude *and* Latitude *of one Place known, and the* Rumb *and distance of a second Place, to find both the* Longitude *and* Latitude *of the second Place.*

SEt the *Zenith* to the Latitude of the first Place, then seek the *Azimuth* which serveth for the Rumb of the second Place, and in that *Azimuth* count his distance from the *Zenith*: where this distance ends there is the second Place, whose Latitude is shewn you by the Parallel which cutteth him, and the Meridian cutting there also, shews his Longitude.



Example. Let Z be *London*, and because *Jerusalem* beareth from *London* almost S *b* E or $77\frac{1}{2}$ from South Eastward, therefore I choose the *Azimuth* $77\frac{1}{2}$ Z K, therein I number *Jerusalems* distance from *London* Z I 2300. miles or minutes, that is 38. 20. minutes. Now in the Triangle Z P I, I may find P I the complement of *Jerusalems* Latitude 58. 05. minutes, and Z P I the difference of Longitude 46, which must be added to the Longitude of *London* to make the Longitude of *Jerusalem*.

CHAP.

CHAP. LXXIV.

The Latitudes *and* Diſtance *of two Places given, to find the* Rumb, *and the difference of* Longitude.

COunt in the Meridian from P (the Pole) the complement of the Latitude of the firſt place, and thereto ſet Z the *Zenith*. Count alſo from P the complement of the Latitude of the ſecond place, and lay your finger on the Parallel at which your number ends. Count alſo from Z the diſtance of the places in Degrees and Minutes, and note the *Almicantar* at which this number ends: where this *Almicantar* croſſeth the aforeſaid Parallel there is C of your Triangle; (but here marked I,) Look what *Azimuth* cutteth here, it ſheweth the Rumb: and the Meridian that cutteth here, (if you count his diſtance from the *Limb*) ſhews the difference of the Longitude of the places. This is ſo plain from Chapter 69, 70, and 73. that it needeth no example. The ſame Scheam ſerveth theſe 4. Chapters.

The end of the Fourth Book.

The Fifth Book.

Shewing the way to reſolve all
GNOMONICAL PROBLEMES,
And to make all ſorts of *SVN DYALS*,
very eaſily by the

PLANISPHEAR.

CHAP. I: *The Preface.*

Of the kinds of Dyals.

ALthough *Gnomoniques* pertain to *Aſtronomy*, yet I think it not amiſs, for the eaſe of the Reader in finding them, to place the *Gnomonical Problemes* in a diſtinct Book by themſelves.

Suns Dyals may be reduced to two ſorts.

Some ſhew the hour by the Altitude of the Sun, as Quadrants, Rings, Cylinders, &c. for the making whereof you muſt know the Suns Altitudes for every day, or at leaſt every 10th day of the year, and for every hour of thoſe dayes: which Altitudes you may find immediately upon this Planiſphear, as in a Table made to your hand, for any Latitude, by Book 3. 25. and ſo make them of any ſhape according to your mind.

The other ſort ſhew the hour by the ſhadow of a *Gnomon*, or *Style*, Parallel to the Axis of the World: and of thoſe I treat cheifly in this Book. Thoſe be all Projections of the Sphear upon a plain which lies Parallel to ſome Horizon or other in the World. And if upon ſuch a plain the Meridians onely be projected, they ſhall ſuffice to ſhew the hour, without projecting the other Circles, as the Ecliptique, the Equator with his Parallels

rallels of Declination, the Horizon with his *Almicantars* and *Azimuths*, which are ſometimes drawn upon Dyals, more for ornament, then for neceſſity.

Chap. II.

Theorems *premiſed.*

For the better underſtanding of the reaſon of Dyals, theſe *Theorems* would be known.

1. That every plain whereupon any Dyal is drawn, is part of the plain of a great Circle of the Heaven: which Circle is an Horizon to ſome Country or other: that the Center of the Dyal repreſents the Center of the Earth and World, and the *Gnomon* which caſteth the ſhade repreſenteth the Axis, and ought to point directly to the two Poles. And if upon the Center of the Dyal you faſten a *Label* with Sights of equal Altitude, and keeping your eye in the line of the Sights turn this *Label* round, you ſhall thereby deſcribe in the Heavens that great Circle wherein your Dyal-plain lies, and ſee where it cuts our Horizon, and how much it is Elevated above it on one ſide, and depreſſed on the other.

2. That thoſe Dyal-plains *Geometrically* are not in the very plains of great Circles; for then they ſhould have their Centers in the Center of the Earth, from which they are removed almoſt 4000. Miles: and in truth they lie in the plains of Circles Parallel to the ſaid Horizons, but ſo near them, that Optically they ſeem to be the plains of thoſe Horizons: becauſe the Semidiameter of the Earth beareth ſo ſmal proportion to the Suns diſtance, that the whole Earth may be taken for one point or Center, without any perceivable error.

3. That (as all great Circles of the Sphear, ſo) every Dyal-plain hath his Axis, which is a ſtraight line paſſing through the Center of the plain, and making right angles with it: and at the ends of the Axis be the two Poles of the plain, whereof that above our Horizon is called the Pole *Zenith*, and the other the Pole *Nadir* of the Dyal.

4. That every Dyal-plain hath two faces or ſides: and look what reſpect or ſituation the North Pole of the World hath to the one ſide, the ſame hath the South Pole to the other, and theſe

these two sides will always receive 24 hours; so that what one side wanteth, the other side shall have; and the one is described in all things as the other.

5. That (as Horizons, so) Dyal-plains are with respect to the Equator divided into 1. Parallel or Equinoctial, 2. Right, 3. Oblique.

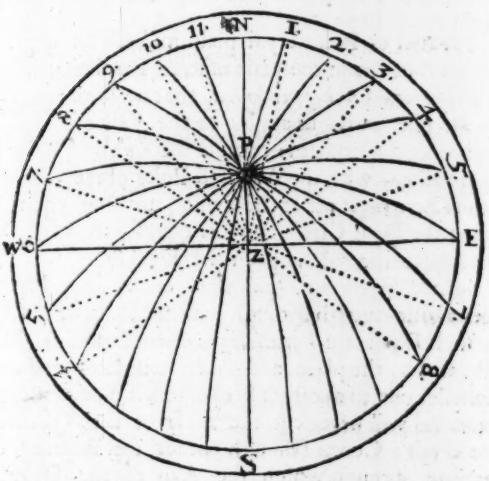
6. A Parallel or Polar Dyal-plain maketh no angles with the Equator: but lies in the plain of it, or Parallel to it. Such Dials are *Sciotherica Orthognomonica*, that is, have the *Gnomon* erected on the plain at Right angles, as the Axis of the World is upon the plain of the Equator: because the Axis and Poles of the Dyal be here all one with the Axis and Poles of the World: and the hour lines here meet all at the Center, making equal angles, and dividing the Dyal Circle into 24. equal parts as the Meridians do the Equator, in whose plain the Dyal lies.

7. A right Horizon or Dyal-plain cutteth the Equator at right angles, and so cutteth through both the Poles of the World. Therefore such Dyals are *Parallelognomonical:* that is have the *Gnomon* Parallel to the plain, and so the hour lines and the hour lines all Parallel one to another: because their plains though infinitely extended will never cut the Axis of the World. Yet have those Dyals a Center, (though not for the meeting of the hour lines) *viz.* through which the Axis of the Dyal Circle passeth, cutting the plain at right angles, and cutting also (near enough for the projecting of a Dyal) the Center of the World.

8. An Oblique Horizon or Dyal-plain cutteth the Equator at Oblique angles: such Dyals are *Scalenognomonical:* that is, have for their *Gnomon* the side of a Triangle whose angles vary according to the more or less Obliquity of the said Horizon: and the *Gnomon* shall always make an angle with the plain of so many degrees as the Axis of the World maketh with the plain; or as either of the Poles of the World is Elevated above the plain.

9. Every Oblique Horizon is divided by the Meridians or Hour Circles of the Sphear into 24. unequal parts: which parts, are always lesser as they are nearer to the Meridian of that Horizon or plain, and greater as they are further off: and on both sides the Meridian of the plain the hour Circles which are equally distant in Time, are also equally distant in Space: whence it is that the divisions of one Quadrant of your Dyal plain being known, the division of the whole Circle is likewise known.

10. The Hour-lines in an Oblique Dyal are the Sections of the plains of the Hour-circles of the Sphear with the Dial plain. And becauſe the plains of great Circles do alwayes cut one ano-



ther in halfs by Diameters, which are ſtraight lines paſſing through the common Center, therefore lines drawn from the Center of the Dyal to the Interſections of the Hour-circles with the great Circle of the plain, ſhall be thoſe very Sections, and the very Hour-lines of the Dyal.

11. Every Dyal-plain (being an Horizon to ſome place in the Earth, as was ſaid *Theorem* 1.) hath his proper Meridian; which is the Meridian cutting through the Poles of the plain, and making Right angles with the plain. If the Poles of the Dyal-plain lie in the Meridian of our place; then is the Meridian of the plain all one with the Meridian of the place; and the *Gnomon* or *Style* ſhall ſtand erected upon the Noon-line, or line of 12 a clock, as in all direct Dyals: but if the plain decline, then ſhall the ſubſtylar or line wherein the *Gnomon* ſtandeth, which is the Meridian of the plain, vary from the Noon-line, which is the Meridian of the place: and this variation ſhall be Eaſt if the Declination

of

of the plain be West, and contrarily: becauſe the viſual lines by which the Sphear is projected on Dyal-plains, do all like the beams of a Burning-glaſs interſect or croſs one another in a certain point of the *Gnomon* (to be aſſigned at pleaſure, and called *Nodus*) and ſo do all place and depaint themſelves on the Dyal-plain beyond the *Nodus* the contrary way.

12. Dyals are moſt aptly denominated from that part of the Sphear where their Poles lie: though ſome Authors have choſen to denominate them from the Circles in which their plains lie: as the Dyal-plain which lieth in the Equinoctial or Parallel to it, is called by many an Equinoctial plain: but I concur with thoſe who would rather call it a Polar-plain; becauſe the Poles thereof are in the Poles of the World.

CHAP. III.

How to draw an Horizontal *or* Vertical *line, upon any plain.*

BEcauſe in the Delineation of moſt Dyals the Horizontal or the Vertical line of the plain muſt firſt be drawn, before you can place the hour-lines; I will ſhew you firſt how to draw either of them. Know this firſt, that they croſs one another at Right angles in the Center of the Dyal: and therefore if you can draw either of them, you may draw the other alſo. Alſo in upright plains as are Walls, a Quadrant or a Square with a Plumbet applied to the Wall, will ſhew you how to draw both of them very eaſily. Or if you hang a Plumb-line quiet before the Wall when the Sun ſhineth, the ſhadow of it ſhall be a Vertical line at any time.

But if the plain incline or recline, you ſhall ſet to it a Square with a Plumbet, and thereby firſt draw the Horizontal line; for when the Plumbet (which muſt play in an hole) hangs Parallel to one ſide of the Square, a line drawn by the other ſhall be Horizontal: that drawn, you ſhall lay your Square flat on the plain, and draw the Vertical from any point of the Horizontal at Right angles by your Square.

Another way is this. Hang your Planiſphear by the handle with his Plumbline, ſo that the Plumbline fall upon one of the Diameters; then ſetting your *Label* and Sights to the other Dia-

8

meter, look through the Sights, and mark where the viſuall line cuts the plain neer to one ſide, and there make a prick, then direct your Sights to the other ſide of the plain, and make another prick, (your *Label* and Plumbline being ſtill at Right angles as before) by theſe two pricks draw a line, and it ſhall be an Horizontal line. And note, that all lines Parallel to an Horizontal line be Horizontal: and all lines Parallel to a Vertical line be alſo Vertical.

CHAP. IV.

How to make the Polar Dyal, *and how to place it.*

THe plain of the Polar Dyal lieth in the Equinoctial: where the 12 cheiſe Meridians or Hour-circles divide both the Equinoctial and this plain into 24 equal parts. The *Gnomon* ſtands upon the Center at Right angles with the plain. You may learn to make him only by the 6. *Theorem* of the ſecond Chapter.

Take your Planiſphear in the Equinoctial Projection, and there is your Dyal ready made on the *Limb*, and the Hours already marked. Erect now a wyer or thred Perpendicular upon the Center, or hold a Square to the Center, ſo that his top be equally diſtant from all the parts of the Circle: and there is your *Gnomon* placed.

To place this Dyal do thus. Having (by Book 4. 3.) found a Meridian line, if you croſs it with another line, that ſhall be an Eaſt or Weſt line. Have alſo in a readineſs a ſquare board upon which you may faſten your Planiſphear or Dyal-plate with pins, ſcrews, or wax, ſo that the Noon-line may be Parallel to two ſides of the board, and the Eaſt-line to the other two: then ſet the North ſide of the board in the Eaſt line, even now found, and raiſe the South ſide by a Quadrant to the height of the Equinoctial; and ſo may you place your Dyal in any Window if it be made upon a looſe round plate; but if the plate be ſquare, you need not the board to place it.

Note that both faces of this Dyal muſt be divided, and the *Gnomon* muſt appear on both ſides, like the ſtick in a Purre (or whirligig) which Children uſe: otherwiſe you muſt turn him upſide down, as oft as the Sun paſſeth the Equinoctial.

CHAP.

Chap. V.

How to make the South Equinoctial Dyal, *or* Parallelognomonical Dyal *direct.*

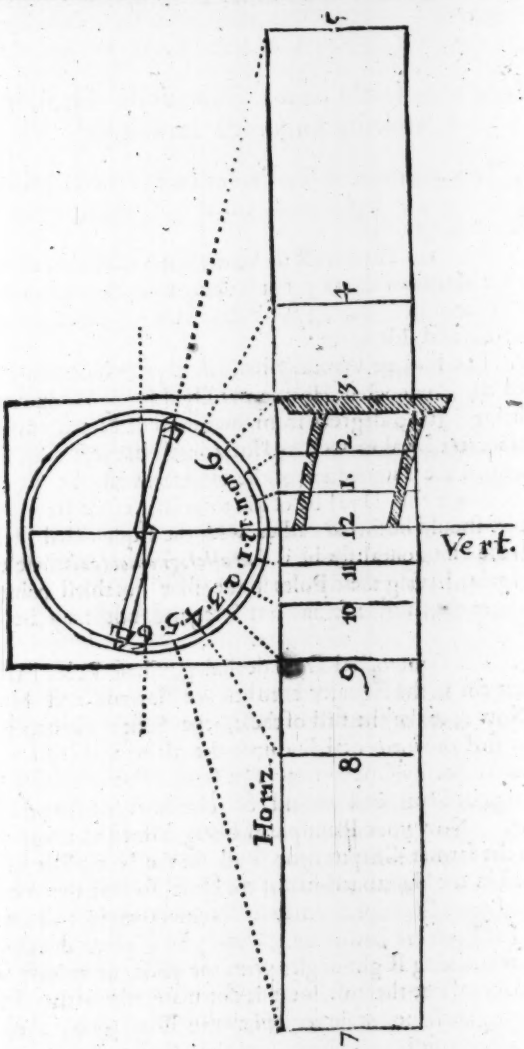
THe Equinoctial Dyal we call that which hath his Poles in the Equinoctial Circle: of which there be three kinds.

1. The direct or South Equinoctial Dyal, which faceth the Meridian directly, not looking from him to one side more then to the other, having his Poles in the Interſections of the Equinoctial and Meridian.

2. The East or West Equinoctial Dyal, which may alſo be called the Equinoctial Horizontal Dyal: for an Horizontal Dyal declining juſt 90 degrees from the South or North, becomes an Equinoctial Dyal, as well as Horizontal: becauſe there his Poles light upon the Interſection of the Horizon with the Equinoctial. And though this Dyal be of kin to both, yet his *Gnomon* ſhews that he ſhould be ſorted rather with the Equinoctial Dyals then with the Horizontal: for he is *Parallelognomonical*: theſe two ſorts be regular, having their Poles in the four notableſt points of the Equator: the third is ſomewhat Irregular, but may be brought to Rule.

3. The Equinoctial Dyal declining, whoſe Poles happen anywhere elſe in the Equator between the Horizon and Meridian.

Now to make the firſt of theſe, the South Equinoctial Dyal, draw firſt an Horizontal-line upon the plain, and croſs it with a Vertical-line, by Chapter 3. The Interſection of theſe is the Center of your Dyal, and would be choſen about the middle of the plain. Now your Planiſphear being faſtned to a ſquare board, as in the former Chapter, you ſhall ſet the North ſide of the ſaid board in the Horizontal-line of the plain, ſo that the Axis or Eaſt line of your Planiſphear may be Parallel thereto, and the Noon-line (or Equator line of the *Mater*) may point directly to the Center, making Right angles with the plain, or at leaſt with the Horizontal line thereof: (for it is not material whether the board be upright, ſlope, or lie flat upon the Dial plain) then placing your Sights firſt in the Noon line, they ſhall point to the Center for the point of 12. thence remove your *Label* to 1. of the clock


Vert.
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5
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12
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10
9
8
7

clock in the *Limb*, and they ſhall point out in the Horizontal line of the plain, the point of Interſection for one a clock, where you ſhall make a prick: In like manner remove your *Label* to 1, 2, 3, 4, and 5. in order, making pricks in like manner. When you remove your *Label* to the Axtree line for 6. you ſhall find that the line of the Sights maketh no Interſection with the plain, but runneth Parallel to it; becauſe the Sun is then in the Horizon of this Dyal, where he projects the ſhadows of all upright things infinite. And as you found the points for the hours afternoon, ſo may you by like reaſon find the points for the 5. morning hours, and their quarters alſo, if you pleaſe: which had, if by theſe points found you draw lines Parallel to the Vertical line of the plain (which is here the Meridian of the plain, and of the place) they ſhall be the true hour-lines. And the *Gnomons* edge muſt ſtand over the Meridian, and Parallel to it, at the ſame diſtance that the Axtree line of your Planiſphear was ſituate in projecting the hour points. If you cannot fix your Planiſphear on a board, as aboveſaid, or if your plain require a *Gnomon* of a greater or leſſer height, you may upon any board preſently draw ſo much of your Planiſphear as ſerves for this purpoſe. Or to ſay more breifly, Do but make the height of your *Gnomon Radius*, and the *Tangents* of 15, 30, 45, 60, 75. ſhall give the diſtances of the hour points in the Horizontal line, on both ſides, from the Center of the Dyal, as may appear in the Figure.

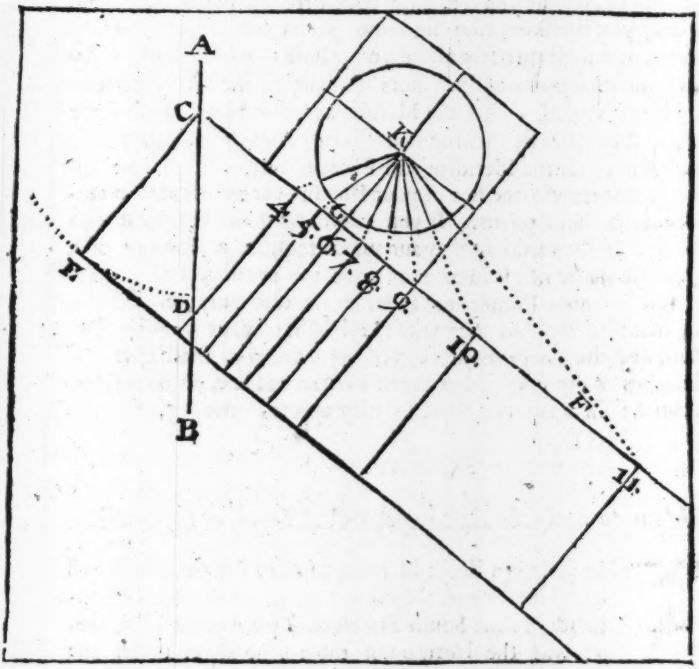
Chap. VI.

How to make the East Equinoctial Dyal, *or the* West.

THis plain is a Right Horizon of thoſe People who dwell under the Equator, diſtant from us 90 degrees of Longitude; as the South Equinoctial-plain of the laſt Chapter was the Horizon of thoſe who dwel under the Equator, in the ſame Longitude with us. Therefore theſe Dyals are in all points alike: onely the Subſtylar-line which in the South Equinoctial Dyal is 12. in this East Equinoctial Dyal is but 6. in the Morning for our Country, becauſe of the difference of Longitude.

To protract this on the wall or plain, firſt draw a Perpendicular or Vertical line by Chapter 3. as A B. Pitch one foot of

your Compaſſes in any convenient point thereof (as C) and with the other foot draw a blind arch from ſome lower point of the Perpendicular South-ward (as D E.) In this arch number the Elevation of the South Pole above this Perpendicular (that is, the Complement of your Latitude, being with us 37. 45 minutes) and from that degree to the Center of the ſaid arch draw the line E C, which is the very Axis of the World, pointing to both the



Poles; Croſs this Axis at Right angles with the line C F, and that ſhall be a Diameter of the Equator and the Contingent-line, as they call it. Now chooſe a fit point in this Contingent for the Subſtyle or 6. a clock point, as at G, and thereto by the ſquare board mentioned in the former Chapter, ſet *Oriens*, or *Occidens*, of your Planiſphear; and ſo the *Label* ſet to the ſeveral hours in the

the *Limb* of the Planiſphear ſhall ſhew the hour-points in the Contingent line: onely for 12. the line of the Sights will not interſect the plain at all, and therefore here is no Noon-line, as there was no 6. a clock-line in the South Equinoctial Dyal: but ſo ſoon as the Sun leaving the plain makes the ſhadow of the *Gnomon* infinite, then it is Noon.

Laſtly, draw a line Parallel to the Contingent line at ſuch diſtance as the plain will afford, as the line E I, and to this you ſhall protract your hour lines, drawing them from every point of the Contingent to this; ſo that they make Right angles with the Contingent and with this Parallel, even as the rounds of a Ladder do with the ſides, but that the diſtance of the rounds of a Ladder are equal, and theſe diſtances be unequal. The *Gnomon* muſt be ſet like a Bridge Perpendicularly over the 6. a clock hour-line, the edge that caſteth ſhadow being Parallel to it, and of ſuch height as the line K G of your Planiſphear, or ſo that if the *Gnomon* fall, his edge may lie in the line of 3. or of 9. of the clock. This alſo may be made ſpeedily by help of the *Tangents*, as the South Equinoctial Dyal.

For the Weſt Equinoctial Dyal, it is made like the Eaſt in all points; onely it ſhews but the after Noon hours, as the Eaſt ſhews but thoſe of the fore noon. When you have drawn on paper the Eaſt Dyal, and ſet it by gueſs in its Situation, go on the Weſt ſide of it, and you may ſee through the paper the picture of the Weſt Dyal, and ſo will the back ſide of the Weſt Dyal ſhew you the true picture of the Eaſt.

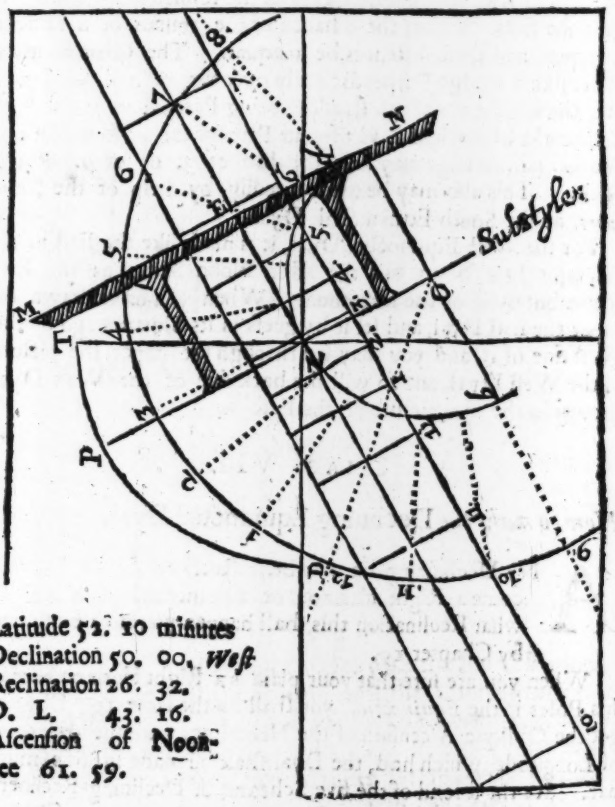
CHAP. VII.

How to make the Declining Equinoctial Dyal.

ANy Declining plain may be ſo Reclined that he ſhall become a Right Horizon or Equinoctial plain, and at what Reclination this ſhall happen you may eaſily find by Chapter 19.

When you are ſure that your plain is a Right Horizon, having his Poles in the *Equinoctial*, you ſhall by the ſame 19th Chapter get the Oblique Aſcenſion of the Noon-line, and the difference of Longitude; which had, the Dyal ſhall be made in this manner. See the ſecond of the five Scheams of Declining-Recliners,

Chapter 20. Draw upon your plain (by Chapter 3.) an Horizontal line D *d* (anſwering to D *d* in the ſaid Scheam) therein take a point at pleaſure, as the point Z, (anſwering to Z in the ſaid Scheam) and thereupon draw above the Horizontal line Weſtward, if the Declination be Weſt (as the ſaid Scheam ſhall direct you) the Quadrant of the plain D P T, (anſwering D *Pro* T of the ſaid Scheam) herein number from D the arch D P, which is the Oblique Aſcenſion of the Noon line, and draw *Z* P for the Axis and common Section of all the Meridians. It appeareth now



Latitude 52. 10 minutes
Declination 50. 00. *Weſt*
Reclination 26. 32.
D. L. 43. 16.
Aſcenſion of Noon-lice 61. 59.

that

that no Dyal can be drawn upon the very plain of a Meridian, for there all the hour lines will be represented by one line, which is the Axis of the World; therefore you must draw such Dyals on a Parallel plain, as you did the two former after this manner.

Set the line M E N for the Axis of the World or *Gnomon*, and prop him up over the line P Z with two props of equal height, and Perpendicular to the plain, and make the point E (which standeth Perpendicularly over *Z*) the Center of the World; then from this Axis or *Gnomon* mounted in the Air, shall the hour-lines be projected distinctly, and all of them shall be Parallel to the Axis and one to another, as it hapneth in all sorts of Equinoctial Dyals. The line Z P shall remain now onely the Meridian of the plain or *Substylar*. And to find the hour-lines you shall do thus.

Draw through Z an Equinoctial or Contingent line E Z, making Right angles with the Axis M E N or Z P, then setting Z O equal to Z E, draw upon the Center O (with an extension of the Compasses,) the arch of the Equinoctial *b* Z *d*, or the Parallel arch passing by D. Then number in this arch from the *Substyle* (Westward if your plain decline West, or Eastward if it decline East) the difference of Longitude, and where it ends there is the point of Noon in this arch: from that point begin to divide the said arch by fifteens of degrees, or 24th parts of the whole Circle. And remember, that when you come to 90 degrees from the *Substyle*, you need divide no further, for the Sun is no longer upon this plain. Also you may leave out those hours at which the Sun is alwayes under our Horizon, as the hours from 8. at Night, to 4 in the Morning: then lay a Ruler from the Center O to every one of these divisions of the Circle, and where the Ruler cuts the Contingent, there make points for the hours respectively, and through these points you may draw the hour-lines Parallel to the *Substyle*, of what length you please; and mark them from the Noon line Eastward 1, 2, 3. &c. because the Suns Diurnal course is Westward, and the course of the shadow is contrary.

He that will may make use of his Planisphear for dividing the hours, as was taught Chapter 4, and 5. or use a *Quadrant*, or a *Scale* of *Chords*, or the Tables of *Tangents* with a *Sector*, or a *Scale* of equal parts. But it needs not.

Note that this Dyal may compare with the hardest: however

Mr *Blagrave* and other Dyaliſts have omitted it, as ſeeming eaſy: and here *Wittekindus*, (to whom all later Dyaliſts are much beholden) and after him *Fale* were miſtaken, uſing the Declination of the plain, where they ſhould have uſed the difference of Longitude in the making of this Dyal.

CHAP. VIII.

Of the kinds of Oblique Dyals.

WHat an Oblique Dyal is, and why it is ſo called, hath been ſhewed Chapter 2. They be { *Regular.* / *Irregular.*

The Regular lie in ſome notable Circle of the Sphear; as, 1. The Vertical Dyal, whoſe plain lieth in the Horizon: for which cauſe many call it the Horizontal Dyal. 2. The South and North Horizontal Dyal, whoſe plain lies in the Eaſt *Azimuth*: and it is commonly called the South or North Erect Direct Dyal. As for the Eaſt and Weſt Dyals, they belong to another place, as was ſaid Chapter 5.

The *Irregular* are ſuch as lie Oblique to the Horizon, as Reclining or Inclining Dyals; or lie Oblique to the Meridian, as Decliners: or elſe Oblique to both, as Recliners or Incliners Declining; which are eſteemed the hardeſt of all, becauſe of their double Irregularity, though by the Planiſphear they are made almoſt as eaſily as the reſt.

The Declination of a plain is the *Azimuthal* diſtance of his Poles from the Meridian of the Place, Eaſt or Weſt.

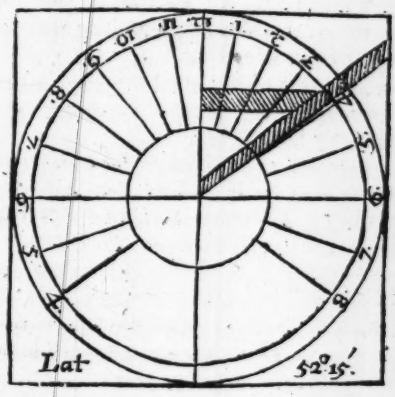
The Reclination is the diſtance of his Poles from the *Zenith* and *Nadir* of your Place. Inclination is the neareſt diſtance of the Poles of the plain from your Horizon. And whatſoever the Reclination of the upper face of a plain is, the Inclination of the lower face is the Complement thereof.

CHAP. IX.

How to make the Vertical Dyal.

IN the Meridional Projection the *Finitor* being ſet to the Latitude of your Place, you ſhall ſee the *Limb* which is your Me-

Meridian, and the Axtree-line which is the ſixt hour-circle, dividing the *Finitor* into 4 Quadrants; and the reſt of the Meridians dividing every Quadrant alike. Mark now at what degree numbred from the *Limb*, every hour-circle (that is, every 15th Meridian being a ragged or blacker line) cutteth the *Finitor*; at the ſame diſtance ſhall the ſame hour-circle cut the *Limb* of your Dyal in the plain.



Example. To make a Vertical Dyal for our Latitude 52 degrees 15 minutes. I ſet the *Finitor* to this Latitude, and becauſe I ſee the Meridian and Axtree divide the *Finitor* into 4 equal Quadrants, therefore I open my Compaſs to the Semidiameter of my Planiſphear, or of any other Circle which I have at hand already divided, and with that meaſure I draw a Circle, and croſs it ſquare with two Diameters dividing it into four equal parts: of which Diameters I appoint one to be the Noon-line, and at the North end thereof I write 12. the other Diameter then is the Eaſt line, and at both ends thereof I write 6. Then I count in my Planiſphear how many degrees from the Meridian or Noon line every other Circle cutteth, and I find that the firſt cutteth 11. 58 minutes, wherefore I take with my Compaſſes from off the *Limb* of my Planiſphear, or other Circle uſed for this purpoſe, the ſpace of 11. 58 minutes, and ſet it in the Circle of my Dyal from 12. both wayes, for the hours of 1. and 11. and becauſe I find the ſecond hour Circle cutting the *Finitor* at 24. 32 minutes, therefore I take in like manner the Chord of ſo many degrees from the *Limb* of my Planiſphear, and ſet it alſo in the Circle of my Dyal both wayes from 12. for the hours of 2, and 10. And when you have done the like for the 3, 4, and 5. hours, you ſhll draw lines from thoſe

thoſe points to the Center, and ſet to thoſe lines from the North Eaſtward 1, 2, 3, 4, 5. and Weſtward 11, 10, 9, 8, 7. And becauſe the Sun in Summer is above our Horizon more then 2 hours before and after 6. (for I ſee the 7th and 8th hour Circles interſecting the *Tropique* above the *Finitor*) and becauſe hour lines equally diſtant from the Meridian or Axtree cut like degrees of the Horizon (as my Planiſphear here ſhews me) and ſo ſhall make equa langles at the Center; therefore laying my Ruler to 7 in the Morning I prolong that line beyond the Center to the other ſide of the Circle for 7 at Night: likewiſe by the prolongation of 8 in the Morning, I make 8 at Night, and by the prolongation of 4 and 5 of the after Noon, I make 4 and 5 of the Morning hours.

Laſtly, for the *Gnomon*, ſet your Compaſſes to the Chord of the arch of the Poles Elevation in the *Limb*: that is, meaſure in the *Limb* from the Pole to the *Finitor*, and ſetting that diſtance in the Circle of your Dyal from 12. either way, make a point, through which if you draw a deleble line from the Center, you have between this line and the line of 12. the angle of your *Gnomon*, by which when you have ſhaped him, you muſt ſet him upright over the 12 a clock line, with the point of the ſaid angle at the Center, and all is done.

Chap. X.

How to make the South *and* North Horizontal Dyal.

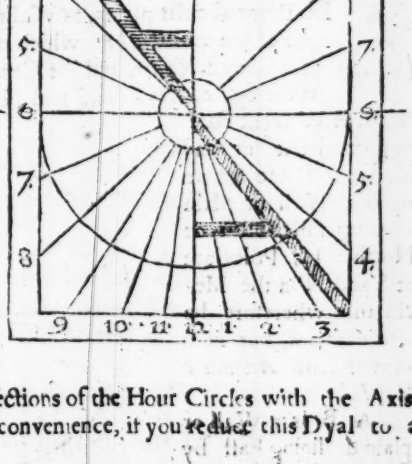
This is uſually called the Erect Direct Dyal, and belongs to an upright Wall looking full North or South: and the plain of it lies in the Eaſt *Azimuth*, which on the Planiſphear in the Meridional Projection is repreſented by the Axis of the *Reet*.

The *Finitor* ſet to the Latitude, as in the former Chapter, mark where the hour Circles cut the Axis of the *Reet*, which is the proper Horizon of this Dyal; you ſhall find the firſt cutteth 9. 20 minutes from the Meridian, the ſecond 19. 30 minutes, the third 31. 30 minutes, the fourth 46. 45 minutes, the fifth 66. 24 minutes; the ſixt 90. And you ſhall ſee the North Pole depreſſed under this plain, as much as is the Complement of our Latitude, and the South Pole as much Elevated above it.

1. Where-

1. Wherefore for the South Dyal, draw an Horizontal line about the top of your Dyal plain, which ſhall be the hour of Sixes, from the midſt whereof let fall a Perpendicular, which ſhall be both the Vertical and the Meridian, both of the Place, and of the Plain, wherein the *Gnomon* muſt ſtand Elevated 37. 45. minutes, or the Complement of your Latitude toward the South Pole.

From the Center (which is the point from whence the Perpendicular falls.) draw a Semi-circle beneath the Horizontal line, of equal Semi-diameter with that of your Planiſphear or of any other Circle which you have divided; and in this Semi-circle ſet off on both ſides from the Perpendicular or Meridian line the diſtances of the hours before found, making pricks in the Semi-circle, and thereto drawing lines from the Center, and ſetting figures, after the ſame manner as you did in the former Chapter; and your Dyal is done. This Dyal ſhews the Hours from 6 in the Morning to 6 at Night; the other Hours before and after 6 belong to the North face of this Dyal.



Another way. Becauſe the Almicantars may oft obſcure the Interſections of the Hour Circles with the Axis, you may avoid that inconvenience, if you reduce this Dyal to a Vertical Dyal.

For the South Horizontal Dyal being the very Vertical Dyal of thoſe People that live 90 degrees Southward from us, that is, in South Latitude 37. 45 minutes, if you ſet the *Finitor* to the Latitude 37. 45 minutes, you ſhall ſee the ſections of the Hour Circles with the *Finitor* more apparently, and thereby make your Dyal,

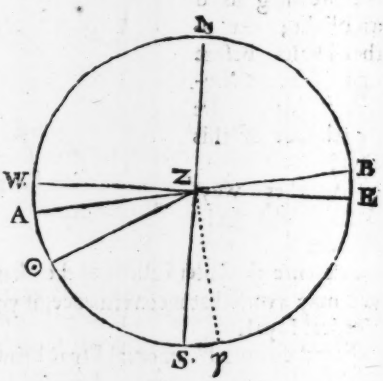
2. For the North face, Imagine you had for your *Gnomon* a wyre thrust aſlope through the Center of the plain from the South ſide Northward and you will preſently conceive that in the North Dyal the Horizontal or 6 a clock line will be loweſt, and that the *Gnomon* will turn upwards toward the North Pole as much as he turned downwards on the other ſide: and that all the hours ſave 4, 5, and 6. in the Morning, and 6, 7, and 8. at Night may be left out in our Latitude; becauſe the Sun ſhineth no longer upon it: and thoſe hour-diſtances you may find, and ſet off from the 12 a clock line, or from the 6 a clock line, as you did the hours of like diſtance in the South face.

Another general and pleaſant way to delineate the oppoſite face of any Dyal, ſee hereafter in the end of the 12th Chapter.

CHAP. XI.

How to Obſerve the Declination *of any* Declining Plain.

ALL Perpendicular plains, as Walls, lie in the plains of one of the *Azimuths*: which plains alwayes cut both *Zenith* and *Nadir*, and the Center of the Earth. As in the figure. Z is *Zenith* and *Nadir*: E S W N Horizon, E W is the Baſe or ground-line, or any Horizontal line drawn upon a Wall or plain looking full South or North; his Poles are at S and N in the Meridian, wherefore he declineth not, but lieth in the Eaſt *Azimuth* E W.



A B is a Wall or plain declining Eaſt by the arch S *p*, to which E B or W A are equal, for ſo much as the Wall bendeth from the Eaſt *Azimuth*, ſo much doth his Pole at *p* decline or bend from the Meridian.

1, Now

1. Now to find how much any plain declineth, and ſo in what *Azimuth* he lies, one good way is this: when the Sun begins to inlighten the Wall, or when he leaves it, then is the Sun in the ſame *Azimuth* with the Wall; take at that inſtant his Altitude, and thereby get his *Azimuth* (according to Book 4. 27.) and that is the *Azimuth* of the Wall.

2. Another way. Firſt draw upon the Wall an Horizontal line, by Chapter 3. then your Planiſphear being faſtned to a Square board (as in Chapter 4.) ſet one ſide of the board to that Horizontal line or Parallel to it, and fix there your board and Planiſphear level, by the help of a Square ſet under him like a bracket, then place your *Label* and Sights in one of the Diameters of your Planiſphear, and mark when the Sun comes into the line of the *Label*, caſting the ſhadow of one Sight upon the other, if the *Label* be then in the Dia meter which is Parallel to the Wall, then is the Sun at that time in the *Azimuth* of the Wall: if the *Label* be in the other Diameter which is Perpendicular to the Wall, then the Sun coming to it is in the *Azimuth* of the Pole of the plain.

Now having the hour, or the Altitude of the Sun get his *Azimuth* (by 4. 27.) the ſame is the *Azimuth* of the Wall or plain, if the *Label* were Parallel to the Wall; or the ſame is the *Azimuth* of the Pole of the plain (that is the very Declination) if the *Label* ſtood Perpendicular to the Wall.

3. Another way. If you have not time to watch till the Sun come into the *Azimuth* of the Wall or the Vertical of it, which cutteth the Pole thereof, then get the Suns *Azimuth* by the ſaid Book 4. 27. when you can, and at the ſame time Obſerve by your *Label* the Suns Horizontal diſtance from the Pole of the plain, and by comparing theſe together you may eaſily gather the Declination of the Wall: as in Example.

I obſerved the Sun to be gone Weſt from the Pole of the plain 70 degrees, and by the Altitude of the Sun then taken, I found his *Azimuth* 60 degrees: here I reaſon thus, The Sun is gone from the Pole and Vertical of the Wall 70 degrees, and from the Meridian but 60 degrees, therefore the Meridian lies between the Pole of the plain and the Sun, and becauſe ☉ *p* is 70. and ☉ S 60. therefore S *p* the Declination of the plain, is 10 degrees the difference of 70. and 60. and the Declination is Eaſt, for the Sun is neerer to the Meridian then to the Vertical of

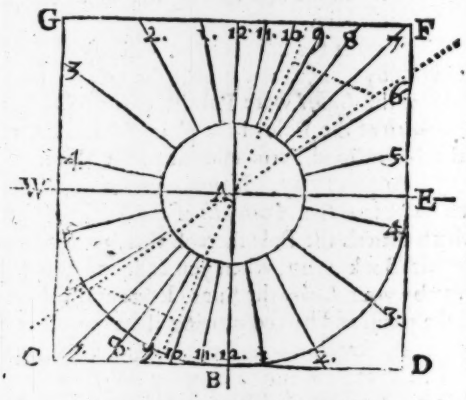
the plain: and thus if you draw a rude Scheam of your Caſe, you may ſoon reaſon out the Declination, better then do it blind-fold by the rules commonly given,

And by theſe two laſt wayes you may take the Declination, not only of upright plains, but of Recliners alſo, for which the firſt way will not ſerve,

CHAP. XII.

How to make a Declining Horizontal Dyal.

HEre three things are required. For beſides the diſtances of the ſeveral hours from 12, and the Elevation of the *Gnomon*, which are requiſite to the making of all Direct and Regular Dyals, we muſt here know alſo the Declination of the *Gnomon*, which ſome call the diſtance of the Subſtyle from the Meridian, or the diſtance of the Meridian of the plain from the Meridian of the Place. For in all Dyals the Noon-line in the Meridian of your Place, projected on the Dyal, and in all Horizontal or Mural Dyals, not Reclining or Inclining, the Noon-line is a Perpendicular cutting the Center of the Dyal, how much ſoever they Decline.



But Declining Dyals which look awry from our Meridian, have a Meridian of their own, which is called the Meridian of the plain, and the Subſtyle, (becauſe the *Style* or *Gnomon* ſtands upon it) and is indeed the Meridian of that Place, where this Declining Dyal would be a Vertical Dyal, and where the Subſtyle would

would be the Noon-line: and to this Subſtyle the hours of the plain are alwayes ſo conformed, that the nearer they be to the Subſtyle the narrower are the hour ſpaces, and contrarily: becauſe the Meridians do ſo cut every oblique Horizon, that is, thickeſt near the Meridian of the place: and this Declining Dyal (being a ſtranger with us) followeth the faſhion of his own Country, and ſo hath his narroweſt hour ſpaces near his own Meridian, rather then ours. Now as that is the Meridian of our place which cutteth our Horizon at Right angles, paſſing through his Poles *Zenith* and *Nadir*, ſo the Meridian of any plain is that which cutteth the plain at Right angles, and paſſeth through his Poles.

You may find all theſe requiſites in the Meridional Projection, not only for one, but for all Declinations, lying as in a Table before you, with admirable eaſe and delight; for there is no Declining Wall or Horizontal plain, but we have an *Azimuth* in the *Rete* which ſhall picture him: and look how the Meridians divide theſe *Azimuths*, ſo do they divide the Horizons or Circles of the Declining plains. The Pole of any *Azimuth* is found in the *Finitor* 90 degrees diſtant from him; the Meridian that cuts the Pole of the *Azimuth*, cuts alſo the *Azimuth*, and the plain thereby repreſented at Right angles, and is the Meridian of the plain or Subſtylar, (Chapter 2. Theorem 11.) and the degrees of that Meridian between the plain and the next Pole of the World are the Elevation of the Pole above the plain: and ſo the Elevation of the *Gnomon* or *Style*, and the arch of the plain comprehended between this Meridian of the plain and the *Limb*, is the Declination of the *Gnomon*, or diſtance of the Subſtyle from the Meridian, or diſtance of the Meridian of the plain from the Meridian of the Place. What would you more?

Example. If a Wall Decline Eaſt 30 degrees. I ſay, becauſe the face of the Wall looketh 30 degrees from the South Eaſtward, therefore the plain, which lieth 90 degrees from his Pole, is in the 30th *Azimuth* from the Eaſt Northward: therefore I go to the 30th *Azimuth* from the Eaſt line or Axis, counted either way, and take that *Azimuth* and his Match (which is equally diſtant from the Axis) for the very picture of my Declining plain.

Then ſeeking the Subſtyle or Meridian of the plain. I ſay, the Pole of the plain is in the *Finitor* at the 30th *Azimuth* from *Me-*

ridies in the *Limb*, (because the plain it self is the 30th *Azimuth* beyond the Axis) the Meridian that cuts this Pole is the $36\frac{1}{4}$ (exactly 36. 8 minutes,) the number whereof shewes me the difference of Longitude between our Country and the Country of this Dyal. This $36\frac{1}{4}$ Meridian, being the Meridian of the plain, I follow toward the Pole, and find him cutting both the arches of my plain on both sides the Axis: but I regard the cutting only in that arch which is neareſt to the Pole, because there the angle looks more like a Right angle, and there is the neareſt diſtance of the Pole from the plain, and there I ſee the hour ſpaces leaſt: from that Interſection therefore, I reckon in the ſame Meridian to the Pole 32 degrees and perhaps a minute more, (you may find it by Calculation,) this is the Elevation of the Pole above the plain, and of the *Gnomon* likewiſe: alſo from the ſame Interſection I reckon in the plain to the *Limb* or Meridian 21. degrees 10. minutes, the diſtance of the Meridian of the plain from the Meridian of the Place: the ſame is the Declination of the *Gnomon*, or of his Subſtyle.

Then for the hours, I begin at the *Zenith* of the *Reet*, where is our Meridian, and numbring firſt toward the Subſtyle, I ſeek at what number of degrees from the *Zenith* the hour Circles cut my plain, and I find as followeth,

	deg.	min.
11.—	9.	35
10.—	17.	54
9.—	25.	54
8.—	34.	22
7.—	44.	17
6.—	57.	10
5.—	75.	4

Then in the other arch of the plain I have the afternoon hours, thus.

	deg.	min.
1—	12.	10
2—	28.	59
3—	52.	26
4—	80.	17

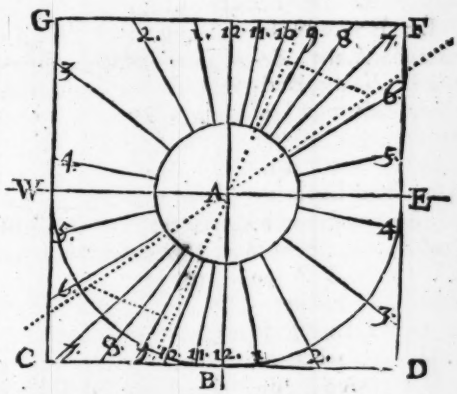
And further I cannot go, becauſe I ſee the next hour is above 90 from the Subſtyle; therefore my Dyal receives him not on this ſide, but on the North ſide there is uſe of him.

Now to draw the Dyal, I conſider that becauſe the plain declines Eaſt therefore the *Gnomon* ſhall decline Weſt: for the Dyal being ſuch a projection of the Sphear wherein all the Vitual lines croſs in the *Nodus* of the *Gnomon*, and thence diſperſe themſelves again toward the plain, therefore that which is Eaſt in the Sphear will be expreſſed Weſt on the plain, and contrarily, (as

was

was shewed Chapter 2. Theorem 11.) Also I consider that howsoever the plain be turned East or West, the *Gnomon's* place is fixed, because it is a part of the Axis of the World, or a line Parallel to it. Now therefore if I turn a South Dyal, and make him Decline East, and hold the *Gnomon* unmoveable; the West side of the Dyal will approach nearer to the *Gnomon*, as reason and sence will tell me: likewise the hours which are found on the same side of the Meridian or Noon-line with the Substile must be set the same way with it from the Noon-line in the Dyal. Therefore having drawn an Horizontal line E W on the Wall, from the Center taken at A, I let fall the Perpendicular A B for the Noon-line, then upon the Center A, I draw a blind Semi-circle with the Semi-diameter of my Planisphear, or of some Quadrant, as E B W and therein I prick down the Substyle and the hours, after the manner used in the 10th Chapter.

And if you would draw the North Dyal of this plain, do but prolong those hour lines, and the Substyle upwards beyond the Center, and you have the North Dyal, above the Horizontal line E W, as the South Dyal below it; and note, that because in our Latitude the Sun sets soon after 8 in Summer, therefore the 3 hours next before and after mid-night may be left out in this Dyal, and in all others which must serve in our Latitude.



This is the most ready way to delineate the opposite face of any Dyal. See another way to make this Declining Horizontal Dyal, Chapter 21.

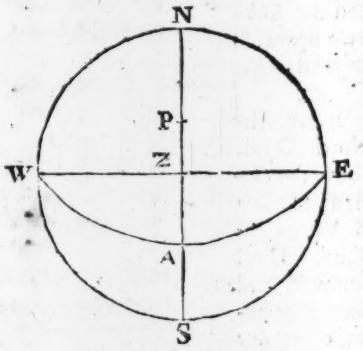
CHAP.

Chap. XIII.

How to Observe the Reclination *or* Inclination *of any* Plain.

What Reclination and Inclination are, hath been shewed Chapter 8.

All Reclining and Inclining plains have their Bases or Horizontal Diameters lying in the Horizontal Diameter of some *Azimuth*: but the top or *Nonagesimus gradus* of the plain from the Horizon leaneth back from the *Zenith* of your Place, in the Vertical of the plain (which is the *Azimuth* cutting the plain at Right angles) so much as the Reclination hapneth to be; and the Pole of the plain, on that side the plain inclines to, is sunk as much below the Horizon as the *Nonagesimus gradus* of the plain is sunk below the *Zenith*, and the opposite Pole is mounted as much.



Let E S W N be Horizon, Z the *Zenith*, E W the Horizontal Diameter of the plain, and of the East *Azimuth* E A W a plain not Declining but Reclining Southward from the *Zenith* by the arch Z A 50 degrees and his opposite face Inclining to the Horizon according to the arch A S 40 degrees, the Pole of the Reclining face is at P in the Meridian (which here is also Vertical of the plain) and is Elevated 50 degrees in the arch N P equal to the arch of Reclination Z A: and the Pole of the Inclining face is depressed as much on the other side under the Horizon.

To find the quantity of the Reclination you shall draw a Vertical line on the plain, by Chapter 3. and thereto apply a long Ruler which

which may over-ſhoot the plain either above or below: to that Ruler apply any Semidiameter of your Planiſphear, or of any Quadrant; and the degrees between that Semidiameter and the Plumb-line ſhall be the degrees of Reclination.

Or ſtick up in the Vertical line two pins of equal height, and Perpendicular, and placing your ſelf either above or below the plain, as you find moſt eaſy, direct the Sights of your Planiſphear or Quadrant to the heads of the two pins being in a right line with your ey; and the Plumbet ſhall ſhew the Reclination on one ſide the Quadrant, and the Inclination (which is alwayes Complement thereof) on the other.

Chap. XIV.

How to make a South *and* North Reclining Dyal.

THe Baſe or Horizontal line of ſuch a Dyal lieth in the Eaſt *Azimuth*, and his Pole in the Meridian; as you may ſee in the plain of the former Chapter. In the Meridional Projection having ſet the *Finitor* to the Latitude, count from the *Zenith* the degrees of Reclination Northward or South-ward as you obſerved it to be, and remove the *Zenith* ſo many degrees the ſame way, then ſhall you ſee preſently which Pole is Elevated above the *Zenith* line, (for that is the picture of your plain) and how much: to which Elevation you ſhall make your Dyal by the tenth Chapter, remembring to turn the *Gnomon* upwards or downwards as the North or South Pole is Elevated above the face of your plain.

Example. The plain of the former Chapter was a North plain Reclining Southward 50 degrees, that is, almoſt to the Equinoctial: when the *Finitor* is at our Latitude the *Zenith* is diſtant from the North Pole the Complement thereof 37. 45. toward the South. Now I muſt put the *Zenith* yet 50 degrees more Southward, becauſe my plain Reclines ſo much that way, and I ſee that then the North Pole is Elevated 87. 45. minutes, and I ſee upon the *Zenith* line or Axis of the *Reet* how the hour Circles cut my plain almoſt in equal ſpaces: if this plain had Reclined but 2. 15 minutes further, he had fallen into the plain of the Equinoctial, and ſo the Dyal would have been a Polar Dyal, and all the hours would have had equal ſpaces, and the

Gnomon would have ſtood Perpendicular, which are the properties of a Polar Dyal, as hath been ſhewed Chapter 4.

For the oppoſite face of this Dyal, the general rule given Chapter 12. may ſuffice.

CHAP. XV.

How to make an Eaſt *or* Weſt Reclining Dyal.

AS it hath been ſhewed Chapter 14. that the baſe or Horizontal line of a South Reciner lieth alwayes in the Eaſt *Azimuth*, ſo the baſe of an Eaſt Recliner lieth alwayes in the Meridian of the Place. And as all Declining plains lie in ſome *Azimuth*, and croſs one another in the *Zenith* and *Nadir*, by Chapter 12. ſo theſe Reclining plains lie in ſome Circle of Poſition, and croſs one another in the North and South points of the Horizon: which being conſidered, thoſe Eaſt Recliners ſhall be made as eaſily as the Decliners Chapter 12.

For theſe Eaſt Recliners be in very deed South Decliners to thoſe that live 90 degrees from us Northward or Southward; and have one of the Poles Elevated as much as the Complement of our Latitude: for the Perpendicular or Plumb-line of thoſe People is Parallel to the Horizontal Diameter of our Meridian.

In the Meridional Projection, ſet the *Zenith* line to the Latitude, and then are the *Azimuths* Circles of Poſition, and are alſo thoſe very Eaſt or Weſt Reclining plains, and the *Zenith* line is the baſe or Horizontal line to them all, and to the Meridian likewiſe; Take any of theſe *Azimuths*, and ſee how the Meridians of the *Mater* divide him, ſo ſhall the Dyal-plain repreſented by it be divided alſo. The working is very like that of Chapter 12. Compare the one with the other where you doubt.

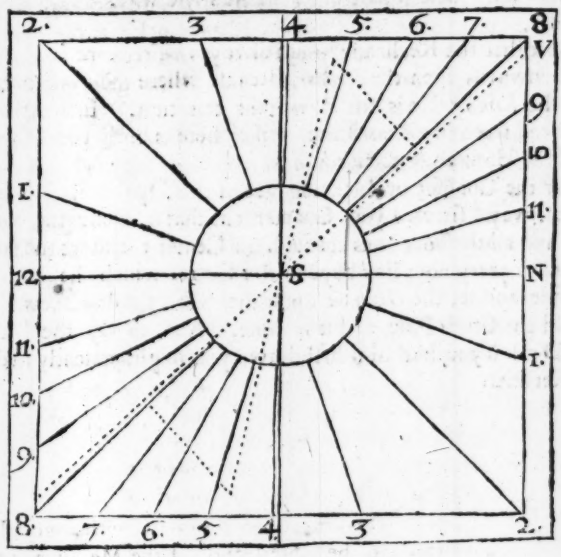
Example. I have an Eaſt plain Reclining 45 degrees, to which I would make a Dyal. I ſet the *Zenith* line to the Latitude 52. 15 minutes, and going to the arch of the 45 *Azimuth* on one ſide the *Zenith* line, and his match ſo many degrees diſtant on the other ſide, I take that Circle for my plain, his Center is the Center of the Planiſphear: the Meridian or Noon line of the Place in theſe Dyals is evermore the Axis or Zenith line of the *Reet*, for he is drawn to the Interſection of the Meridian of the

Place

Place (here the *Limb*) with the plain. The *Zenith* line here lies Horizontal, therefore the Noon line in these East Recliners must be evermore the Horizontal line of the Dyal, as in all Decliners (Chapter 12.) the Noon line is evermore the Vertical or Perpendicular line.

The arch of my plain which is neareſt to the North Pole hath his Pole in the *Finitor* 45 degrees from the Center Southward, and there this Pole is cut by the Meridian 31 $\frac{1}{4}$. from the Axis, this is the Meridian of my plain, and he is diſtant from the Meridian of the Place 58 $\frac{3}{4}$. (which is the difference of Longitude) this Meridian I follow to the arch of the plain which is neareſt to the North Pole, and ſo going on in him to the Pole I number in him between the plain and the Pole 34 degrees, which is the Elevation of the Pole, and therefore alſo of the *Gnomon* above this plain: and between this Meridian of the plain and the Meridian of the Place at *Zenith* I reckon in the plain 42 $\frac{1}{2}$ for the Declination of the *Gnomon*.

Wherefore having drawn an Horizontal line N S for the Noon line, I appoint the Center at S the South end, becauſe



the North Pole is Elevated, and drawing a blind arch, ſet therein from the Horizontal line upwards 42 $\frac{1}{2}$. and there draw the Subſtyle S V.

Then I ſeek my hour diſtances, and I find the firſt hour-circle from the Meridian toward the Subſtyle cuts in the plain 14 $\frac{1}{2}$, therefore taking 14 $\frac{1}{2}$ in the blind arch from the Noon line toward the Subſtyle, I ſet 11. for ſo it is, and not 1. as you may preſently perceive, if you hold but a Book or a Trencher after the Situation of your plain, ſomewhat near by gueſs, and conſider which way the ſhadow muſt move, reaſon will tell you it moves downward in this Dyal from 11. to 12. &c. then I ſee the ſecond hour-circle cuts the plain at 25 $\frac{1}{2}$ for 10. the next at 34 $\frac{2}{3}$. for 9. the next at 43. for 8. which happneth a little above the Subſtyle, as he ought, for the difference of Longitude is almoſt 60. *viz.* 58 $\frac{3}{4}$. as before, next 51 $\frac{1}{2}$. for 7. next 61 $\frac{1}{3}$ for 6. next 73 $\frac{1}{3}$ for 5. next 88 $\frac{1}{2}$ for 4. and further I need not go in our Country.

Then in the other arch of the plain I find 19 $\frac{1}{2}$ for 1. 45 for 2. 71 for 3. and theſe I put in their places, as in the Figure. The *Gnomon* muſt ſtand ſquare upon the Subſtyle, at an angle of 34 degrees.

Note that the Reclination muſt alwayes be reckoned from the *Limb* inwards upon the *Finitor*, becauſe where the *Finitor* touches the *Limb* there is our *Zenith* for this turn. Inclination is reckoned from the *Zenith* line, which here is both the Diameter of the Horizon, and Horizon it ſelf.

For the Oppoſite or Inclining face of this Dyal-plain, uſe the general way I ſhewed you, Chapter 12. that is, ſtrike the Subſtyle and all the hour lines through the Center: and ſet the ſame figures to every hour line beyond the Center which he had on this ſide, and ſet the *Gnomon* upon the Subſtyle downward to behold the South Pole, and it is done. And ſo by the Inclining Dyal, if you had him firſt drawn, you might preſently make the Recliner.

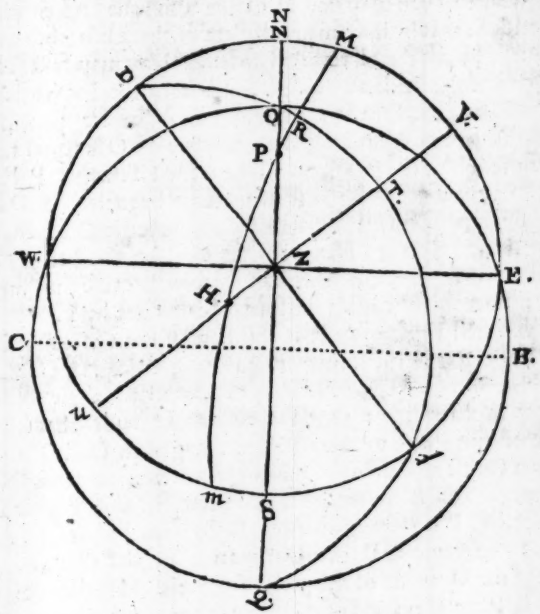
CHAP. XVI.

How to find the Arches and Angles that are requisite for the making of the Reclining Declining Dyal.

BEfore you can Intelligently make a Reclining-Declining Dyal, which is the most Irregular of all, having two *Anomalies, viz.* Declination and Reclination, you must be acquainted with 3 Triangles in the Sphear, wherein certain arches and angles lie which are needfull to be known.

I advise you therefore first to draw (though it be but by aime) an Horizontal Projection of the Sphear, such as here I have drawn for a South Dyal Declining West 50 degrees, and Reclining 60 degrees in the Latitude 52. 10. minutes, which shall be our Example.

The Circle E S W N is our Horizon N S our Meridian.



D T *d* the plain, Z T the Reclination thereof.

D *d* the Baſe or Horizontal line of the plain.

V *u* the Vertical of the plain cutting it right in T, and cutting the Pole thereof at H: for *u* is the Pole of a plain erected upon D *d*; but the Pole of the Reclined plain D T *d* is H.

S *u* or N V the Declination of the plain.

M P H *m* the Meridian of the plain, cutting the North Pole at P, the plain in Right angles at R, and the Pole thereof at H.

Now ſee your three Triangles all adjoyning in this Scheam, *viz.* D N O and O R P Rectangled at N and R, and P Z H. Obtuſe-angled at Z.

It is true that the laſt Triangle alone may do your work, or the two firſt may do it without the laſt: but you ſhall do well to be acquainted with them all.

In the firſt Triangle D N O you have given D N 40 degrees the Complement of the plains Declination, N the Right angle of our Meridian with our Horizon, D the Complement of Reclination, whereby you may find D O the Oblique Aſcenſion of our Meridian; that is, how many degrees of the plain the noon-line ſhall lie above the Horizontal line: alſo you may find N O the Perpendicular Altitude of the noon-line, or the Inclination of the noon-line of the Dyal to the Horizon; (where you ſhall note that when this Altitude of the noon-line N O is equal to N P the Elevation of the Pole, then is the ſecond Triangle P R O quite loſt in the point P, and the plain then becometh a Declining Equinoctial plain) alſo you may find the angle O called the Poſition-Reclination for a reaſon hereafter to be ſhewed; *Wittekindus* calls it, *Complementum repetendum*, becauſe he means to have a Bout with it again, to find other arches by it.

In the ſecond Triangle O R P you have given O, as before, for this angle was in the former Triangle, or his equal, (for *Anguli precrucem oppoſiti ſunt æquales*) R the Right angle of the plain with his Meridian: O P the poſition Latitude, that is, the Latitude of that Place wherein the Reclining plain O R T *d* Q, ſhall be a Circle of Poſition: this is given if you ſubtract N O the Perpendicular Altitude of the noon-line, out of N P your Latitude, (this O P is *Wittekindus* his *Differentia Retenta.*) And hence may be found O R the Declination of the *Gnomon*, or diſtance of the Meridian of the plain from the Meridian of the Place: R P the Elevation of the Pole above the plain in the

Plains

Plains own Meridian: P the angle between the Meridian of the plain and the Meridian of the Place: this angle is called the difference of Longitude, becauſe it ſhewes how far the places are diſtant from us in Longitude, wherein this Dyal ſhall be a Direct Dyal, without Declination, having his *Gnomon* in the noon-line of the Place, and and ſhews alſo how many degrees of the Equinoctial, or how many hours and minutes there are between our Meridian and the Meridian of the plain, as the arch O R ſhews how many degrees of the plain come between the ſaid Meridians. Let this be well obſerved by Learners.

In the Third Triangle P Z H, you have given P Z the Complement of your Latitude, Z H the Complement of the plains Reclination, and Z the Supplement of the plains Declination.

Hence may be found H P whoſe Complement is P R the Elevation of the Pole above the plain, P the difference of Longitude, H whoſe meaſure is R T the arch of the plain between the Meridian of the plain or Subſtyle and the Vertical line of the plain, the Complement whereof is R D the Subſtyle's diſtance from the Horizontal line of the plain.

Every arch and angle therefore in theſe Triangles is given, or may preſently be found by the Problemes of Spherical Triangles, Book 3.

But I ſhall ſhew you a ſhort and pleaſant way to find them, by ſetting the whole Scheam at once on your Planiſphear, where you ſhall have them almoſt all at one view.

For this purpoſe I uſe my Planiſphear in the Horizontal Projection. But note, that I make uſe onely of the *Reet* and *Label*, and one of the Meridians of the *Mater*.

Thus I ſet D *d* on the Axis of the *Reet*, D T *d* on the 60th *Azimuth* from the Center, V *u* on the *Finitor*, Z N on the *Label*, fixing it in the *Limb* of the *Reet* 40 degrees from the *Zenith*, according to the arch D N. Then in the *Label* I make a prick with ink at P for the North Pole 52. 15. minutes within the *Limb*, and another prick in the *Finitor* at H for the Pole of the plain 30 degrees from the Center; which done, and keeping my *Label* fixed to my *Reet*, I turn the *Reet* till I ſee ſome one Meridian cutting both the pricks P and H, (as the 15 Meridian from the Axis ſhall do in this Example) and that Meridian ſhall ſerve for the Meridian of the plain for this time.

And by this time I ſee my three Triangles on my Planiſphear, and

their ſides divided into degrees, as a Carpenters Rule into Inches, and I find for the Latitude 52. 10. minutes, that D O the Oblique Aſcenſion of the Meridian is 44. 06.

N O the Altitude of the Meridian 20. 22. minutes.

O P the Poſition Latitude 31. 48. minutes.

O R the Declination of the *Gnomon* (13. 21. minutes) from the Meridian.

R P the Elevation of the *Gnomon* 29. 08. minutes, and P H Complement thereof,

H the diſtance of the Meridian of the plain and Vertical thereof, you may ſee by the arch of the plain which meaſureth the angle H, 32. 32. minutes.

Now have you nothing to ask of the third Book, but the angles O and P, and there you have divers wayes to find that.

O the Poſition-Reclination is 67. 29. minutes.

P the difference of Longitude 26. 00 ½. minutes.

Chap. XVII.

How to find the Horary *diſtances of a* Reclining Declining Dyal.

TAke the eaſieſt way firſt. You have ſeen Chapter 15. how eaſily Eaſt and Weſt Reclining Dyals are to be made by the Planiſphear, becauſe they fall out to be Circles of Poſition, and are plainly pictured by the *Azimuths*.

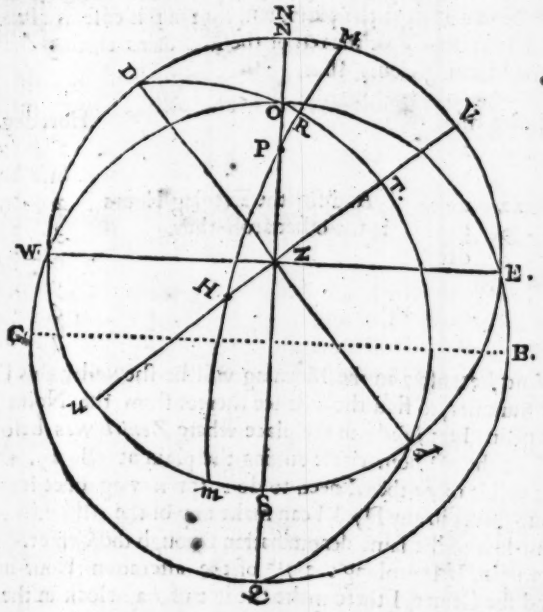
Now I will ſhew you how all Reclining Dyals may be reduced to Eaſt or Weſt Recliners, for ſome Latitude or other, and ſo the hour diſtances found by the Method of the 15th Chapter.

The Circles of Poſition, as hath been ſhewed, do all croſs one another in the North and South points of the Meridian. Now therefore by the point O where the plain cuts our Meridian, draw a new Horizon O B Q C, and then ſhall you ſee your plain in that Horizon to be a very Circle of Poſition. But now we are gotten into a new Latitude, O P called (before in Chapter 16) the Poſition Latitude, and we have here a new Reclination, for whereas this plains Reclination in our Latitude is Z D T 60 degrees, his Poſition Reclination is O, *viz.* Z O T, or P O R 67. 29. minutes.

In

In the making of this Dyal therefore, you ſhall forget your own Latitude, and the plains Reclination in your Horizon, and with this new Latitude and Reclination make the Dyal after the manner of the Eaſt Recliner, Chapter 15. not regarding the Declination at all: For the Baſe of this plain is now fallen into the Horizontal line of the Meridian, and his Declination being juſt a Quadrant, he becomes a Regular Plain, and neither his Declination nor his Reclination ſhall now much trouble you.

How to place your Noon-line from the Horizontal or Vertical line of the plain, you have found already, and at what diſtances every Hour ſhall ſtand from the Noon-line in the plain you ſhall thus find.



Set the *Zenith* line of the *Reet* to your new Latitude P O 31. 48 minutes, and find for your plain the *Azimuth* 67 ½ from the Axis, becauſe P O R is 67. 29 minutes, as before: ſeek his Pole in the *Finitor*, which will be the 90th degree from the ſaid *Azimuth* or plain, and you ſhall find that Pole cut by the 26.

Meridian: this therefore is the Meridian of my plain, and ſhall make the Sub-ſtyle on the Dyal: his diſtance from the Meridian of the Place in the Equinoctial is 26. and ſo much is the angle O P R the difference of Longitude, as before: then follow this Meridian of your plain to that arch of the plain which is next the Pole of the World, and you ſhall number from the plain to the Pole in the ſaid Meridian 29. 08 minutes for the Elevation of the *Gnomon* P R, as before: and from this Meridian to the Meridian of the Place at the *Zenith* you ſhall number in the plain 13. 21 minutes for O R, the Declination of the *Gnomon*, as before.

Now the croſſing of the plain with the Meridian of the Place is the Noon-point in the plain, and that in this caſe is alwayes in the *Zenith*, and I ſee the reſt of the Meridians cutting the plain for the Morning Hours, thus.

Hor.	deg.	min.
8—	68	28
9—	41	23
10—	22	28
11—	9	35
12—	0	00

And for the Evening Hours in the other arch, thus.

Hor.	deg.	min.
1—	7	56
Sub.	13	21
2—	15	18
3—	22	52
4—	31	32
5—	42	36
6—	58	18
7—	81	35

And becauſe 7 in the Morning will be ſhewn by this Dyal in the Summer; to find the diſtance thereof from the Noon-line in the plain, I ſet *Nadir* in the place where *Zenith* was before, and ſo I ſee the 7th hour-circle cutting the plain at 98. 25. minutes. But this is more then I need to do: for having once found 12. Hour-ſpaces in any Dyal, I can make any of the reſt by ſtriking the Hour-line of the ſame denomination through the Center. As for Example. If I prolong the 7th of the afternoon Hour-lines beyond the Center, I there make the line of 7 a clock in the Morning.

CHAP.

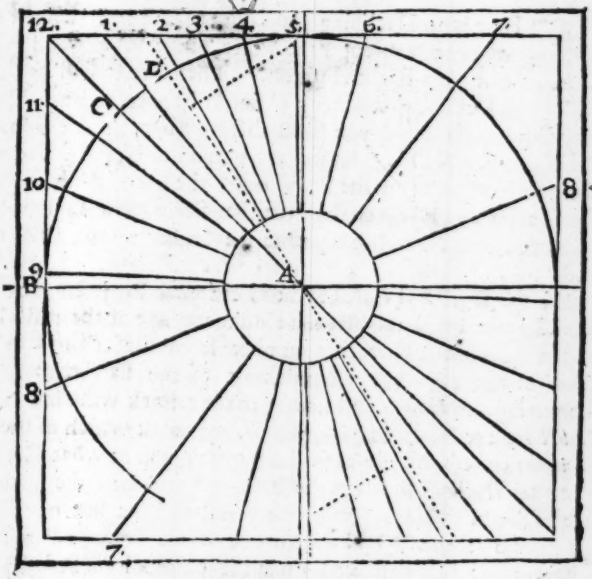
CHAP. XVIII.

How to draw the Reclining Declining Dyal.

FIrst draw an Horizontal line, as A B and upon the Center A describe a blind Circle equal to the *Limb* of your Planiphear, or of some other Circle which is divided to your hand, that by help thereof you may presently divide this blind Circle into any parts required Then set in this blind Circle the arch D O the Oblique Ascension of the Noon-line 44. 06 minutes from B upwards at C and from C yet upwards (as the Scheam shews you) set the arch O R 13. 21. for the Declination of the *Gnomon*: and draw the lines A C for the Noon-line, and A D for the Sub-style.

Then set off the distances of the several Hours from the Noon-

The North Face.



The South Face.

line on both ſides, *viz.* the Morning Hours below the Noon-line Weſtward, and the Evening Hours above it Eaſtward: as you may be taught by Chapter 2. Theorem 11. and by your own reaſon.

And laſtly ſet the *Gnomon* Perpendicular upon the Sub-ſtyle A D, making his angle at A equal to the arch P R, found above to be 29.08. minutes, and your Dyal is done.

CHAP. XIX.

How to know at what Reclination *any* Declination Plain *ſhall become a* Declining Equinoctial Dyal-Plain, *to be delineated after Chapter 7. And how to find the* Oblique Aſcenſion *of his* Meridian *or* Subſtyle, *and the difference of* Longitude, *which are requiſite for his Delineation.*

THere is no Declining plain but at ſome certain Reclination cutteth through the Poles of the World and ſo becometh a Right Horizon. Therefore to find whither a Declining Reclining plain do happen to be a Declining Equinoctial plain, you ſhall obſerve what the Elevation of the Noon-line N O is; for if that be equal to N P the Latitude, then doth the plain cut the Poles, otherwiſe not: And at what Reclination any Decliner ſhall cut the Poles, and ſo have the Altitude of his Noon line equal to the Latitude, you ſhall thus find.

Uſe the *Reet* and *Label* in the Horizontal Projection as you did Chapter 16. that is, ſet the Horizontal line of the plain D *d* on the Axis of the *Reet*, then number from the *Zenith* in the *Limb* of the *Reet* the Complement of the Declination, and thereto lay the *Label*, and having made a prick with ink in the *Label* for the Pole ($52\frac{1}{4}$ from the *Limb*) mark which of the *Azimuths* cutteth that Pole for he ſheweth you at what Reclination that Decliner ſhall cut the Pole and fall into the plain of one of the Meridians. And now you ſhall have but one Triangle to reſolve, *viz.* D N P, (for the whole Triangle P R O of Chapter 16. is ſwallowed up in the point of the Pole P) and and D N P hath all his ſides known, and the angle D at firſt

Sight;

Sight; and for P you may find him if you turn the Triangle as Book 3. hath been ſhewed.

Example. I would make an Equinoctial Dyal in the Weſt Declination 50. degrees, Lay the *Label* therefore 50. degrees from the *Finitor*, or 40. from the *Zenith*, and ſo the Axis of the *Reet* repreſents the plain Declining 50. degrees and the *Label* repreſents the North part of the Meridian, and now I ſee the *Azimuth* 26 ½ from the Axis cutting the *Label* in the place of the Pole; therefore I ſay, that *Azimuth* repreſents the Equinoctial plain which belongs to this Declination.

And now I ſee the Triangle D N P on my Planiſphear, N P on the *Label* is the Latitude, and alſo the Altitude of the Noon line 52. 10. minutes, D N Complement of the Declination 40. D P the Oblique Aſcenſion of the Noon line 61. 59. minutes, N is a Right angle, D is Complement of the Reclination 63. 28. minutes, (whoſe meaſure in the Scheam is T V) P the Complement of the difference of Longitude, for the difference of Longitude it ſelf in the Scheam is H P Z, and the Complement thereof Z P T to which D N P is equal, by the Structure for it is *Angulus pre decuſſim oppoſitus*: and by any of the four firſt Problemes of Rectangled Triangles you may find it to be 46. 44. minutes, whoſe Complement is 43. 16. minutes, the difference of Longitude. The Oblique Aſcenſion of the Noon line, and the difference of Longitude thus found, you ſhall have enough to make the Dyal by Chapter 7.

Chap. XX.

An Admonition *concerning the five ſeveral Caſes of* Declining Recliners.

Becauſe by the diverſity of Declination and Reclination, the figure and ſituation of the three Triangles mentioned Chapter 16. is ſo changed that you cannot alwayes find them on the ſudden, unleſs you have a firm comprehenſion of the Sphear in your head; and in the Caſe of the laſt Chapter the middle Triangle is quite loſt, having all his ſides and angles contracted into the very point of the Pole; therefore I have thought good to ſet down the 5 ſeveral Caſes of theſe Dyals in ſo many ſeveral Scheams, and in every Scheam to mark the Tri-

angles with the ſame Letters, that what Caſe ſoever ſhall happen to be propoſed; you may have a Scheam ready to direct you.

And to know which Scheam ſhall ſerve to expreſs the ſituation of your plain, take theſe Rules

1. If the plain Recline North below the Pole, ſo that the arch N O the Perpendicular Altitude of the Noon line be leſs then N P the Elevation of the North Pole, then the firſt Scheam ſerves your Caſe.

2. If the plain Recline to the Pole making N P and N O equal, you ſhall uſe the Second Scheam.

3. If the plain Recline not ſo far as the Pole, but make N O greater then N P, you ſhall uſe the Third Scheam,

4. If the plain Recline Southward, then inſtead of the Triangle D N O you ſhall uſe the oppoſite Triangle *d* S O, where if S O be greater then the Elevation of the Equator or equal to it, you ſhall uſe the 4th Scheam. And if it be leſs, you ſhall uſe the Fifth.

And note that in the Fifth Caſe you may beſt do your work by the Triangle P H Z alone, (the Triangle P R O being here too big) ſetting off your Sub-ſtyle from the Vertical by the meaſure of the angle H, or of the arch T R, the Noon line from the Sub-ſtyle.

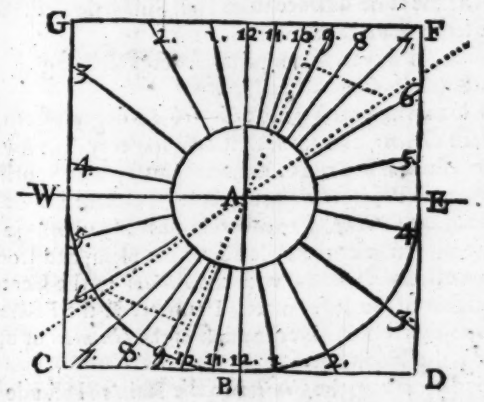
Chap. XXI.

How to make the Declining Horizontal Dyal, *another way then was ſhewed Chapter* 12.

THough you have in the former Chapters a perfect Method for the making of all ſorts of Dyals which give the Hour by the ſhadow of the Axis of the World, or a *Gnomon* ſet Parallel to it; yet I think it both pleaſant and profitable for the Reader to ſee ſome other ways whereby the ſame things may be performed.

For the Declining Horizontal Dyal you ſhall firſt find the Elevation and Declination of the *Gnomon* after this manner. Take your Planiſphear in the Horizontal Projection, and for the help of your fancy, lay it flat upon a Table, ſetting the Meridian, that is, the Equator line of the *Mater* in the Meridian of your Place by aim. Then ſet the *Finiter* for your plain; and his Pole (which

(which is the *Zenith* of the *Reet*) ſhall be Eaſtward or Weſtward from the Meridian of the *Mater* ſo much as you obſerved the Declination: then ſeek the place of the Pole in the Meridian, *viz.* the North Pole 37. 45. minutes Northward from the Center, if the Wall look North, or the South Pole ſo much Southward, if the Wall look South: and it where not amiſs if the Poles



were there marked with an *Aſterisk*, or ſome ſuch note, 38. or 40. degrees from the Center, ſomewhat near your Latitude, ſo theſe *Aſteriſks* (if they be not exactly the Poles for your Latitude) ſhall direct you to find the Poles preſently, being very near them: as if the *Aſterisk* be at 50. I know 2 $\frac{1}{4}$ more inwards is my Pole for Latitude 52 $\frac{1}{4}$. Next look what *Azimuth* cutteth this Pole, for he ſhall repreſent the Meridian of the plain; follow him to the *Finitor*, and you may number as you go the Elevation of the Pole above the plain; and the degrees of the *Finitor* between this *Azimuth* and the Center are the degrees of the Declination of the *Gnomon* or diſtance of the Sub-ſtyle from the Meridian.

2. Having found theſe two, You ſhall ſet your Planiſphear in the firſt Mode of the Meridional Projection: that is, Set the *Finitor* to the Elevation of the Pole above the plain, ſo ſhall you have all your Hour diſtances diſtinguiſhed upon the *Finitor* by the Meridians. But here you muſt carry this in your head, that here the *Limb* is not the Meridian of your Place, but of the plain;

plain; and then to find the Meridian of your Place, number from the *Limb* in the *Finitor* the Declination of the *Gnomon*, and the Meridian cutting there is the Meridian of your place, and ſtands for Noon: therefore every 15th Meridian numbred from hence (and not from the *Limb* in this Caſe) is an Hour line for your Dyal: and look at what diſtance from the *Limb* they cut the *Finitor*, at the ſame diſtance from the Sub-ſtyle ſhall the Hour-lines be ſet in your Dyal plain.

Example. I have a South plain Erect Declining 30. degrees Eaſtward, (as in Chapter 12.)

And for this, Firſt I ſet the *Zenith* 30 degrees from *Meridies*, toward *Oriens*, and ſo doth the *Finitor* repreſent my plain, and I ſee the *Azimuth* 21. 10. minutes cutting the South Pole of the Horizontal Projection about 38 degrees from the Center; from the Pole to the *Finitor* I number in this *Azimuth* 32. 01. minutes, the Elevation of the Pole above the plain; and from the Interſection of this *Azimuth* with the *Finitor* to the Center where the Meridian of the Place meets, I number in the *Finitor* 21. 10. minutes, ſo much is the Declination of the *Gnomon* or of his Sub-ſtyle from the Noon line.

Secondly, ſetting the *Finitor* to the Plain's Latitude 32. 01. minutes, I number from the South point of the *Finitor* inwards 21. 10. minutes, and there cuts the Meridian 36. 08. minutes from the *Limb*, ſhewing me the difference of Longitude, or Equinoctial diſtance of the Meridian of the Place from the Meridian of the plain; for this 36 Meridian is the Meridian of my Place, and therefore I mark him well, he is the Vertical of my Dyal, and alſo the Noon line. And here I conſider that the Sub-ſtyle will be Weſtward from him upon the plain, becauſe it Declines Eaſtward (by Chapter 2. Theorem 11.) Therefore beginning at Noon, where the 36 Meridian cutteth the *Finitor* I go 15. toward the *Limb*, and light upon the 21th Meridian from the Sub-ſtyle for 11 a clock, and he cutteth the *Finitor* at 11. 35. minutes from the *Limb*: ſo the 10th Hour is the ſixt Meridian on this ſide the *Limb*, and cutteth the *Finitor* 3. 16. minutes; the 9th Hour is the ninth Meridian beyond the *Limb*, as you come back again, and cutteth the *Finitor* at 4. 44. minutes from the *Limb* or Sub-ſtyle on the other ſide (that is, Weſtward of the Sub-ſtyle in the Dyal.) In like manner you may gather the diſtances of the other Hour lines from the Sub-ſtyle into a Table, and thereby plot them down as in the Figure.

CHAP.

CHAP. XXII.

To make the Reclining Declining Dyal, *another way.*

HAving found the arches and angles requiſite by Chapter 16. and platted down your Horizontal and Vertical lines, and placed the Noon line above or below the Horizontal line, according as the arch of his Oblique Aſcenſion or Deſcenſion requireth, and having placed alſo the Sub-ſtyle in his due ſituation as is above taught, you may eaſily find the diſtances of the ſeveral Hours from the Sub-ſtyle, as you found them in the former Chapter for the Declining Horizontal Dyal.

For when you have ſet the *Finitor* to the Latitude of your plain, as there you did, the *Limb* is Sub-ſtylar, and if you number thence in the *Finitor* the Declination of the *Gnomon*, there ſhall meet you the Meridian of the Place. Here you ſhall begin, and take every 15th Meridian forwards and backwards for an Hour line, and obſerving how many degrees are in the *Finitor* between the *Limb* and every one of theſe Hour lines, ſo many degrees ſhall you place that Hour line from the Sub-ſtyle in the plain. If you underſtand the former Chapter this will need no Example.

CHAP. XXIII.

To draw the proper Hours of any Declining Dyal.

EVery Declining plain, whether it Recline or nor, hath two great Meridians much ſpoken of. 1. The Meridian of the plain, which is the proper Meridian of that Country to whoſe Horizon the plain lieth Parallel. 2. The Meridian of the Place, which is the Meridian of your Country, in which you ſet up this Declining plain to ſhew the Hours; and ſo either of theſe Meridians Dyals may be conformed. How to draw the Hours of our Country on ſuch a plain is the harder work, becauſe the plain is Irregular to our Horizon: yet I ſuppoſe I have made the way very eaſy in the former Chapters. But to draw the Hours of the Country to which the plain belongs, is moſt eaſy. For if you take the Sub-ſtylar for the Noon-line,

and the Elevation of the Pole above the plain for the Latitude, you may make this Dyal in all points like the Vertical Dyal, after the precept of the 9th Chapter.

Chap. XXIV.

To know in what Country any Declining Dyal *shall serve for a* Vertical Dyal.

If the Dyal Decline East, add the difference of Longitude (found as above Chapter 21.) to the Longitude of your Place, and the sum or the exceſs above 360 is the number of the Longitude ſought. If the Dyal Decline Weſt ſubtract the ſaid difference of Longitude out of the Longitude of your Place, and the difference is the Longitude inquired: but when the Longitude of your Place happens to be leſs then the difference of Longitude you muſt add to it 360. before you ſubtract the difference of Longitude. The Elevation of the Pole above the plain is the Latitude of the Place inquired.

Example. The Declining plain of Chapter 12. will be a Vertical plain in the Longitude 61. degrees, and North Latitude 32. degrees, that is, in the *Mediterranean Sea* between *Alexandria* and the Iſle of *Creet*. And the Declining Reclining plain of Chapter 16, 17, 18. is Parallel to the Horizon of thoſe that ſail in Longitude 359. degrees, and North Latitude 29. degrees, that is as *Terreſtrial Globes* and *Mapps* ſhew me, between the *Azores* and *Heſperides*.

Chap. XXV.

To ſet a Plain Parallel *to the* Horizon *of any Country propoſed.*

If you can get the Declination and Reclination of ſuch a plain, you have enough to place him in his true Situation. And thoſe may be found by the difference of Longitude and the Latitude of the ſtrange Country, (which are in this Probleme ſuppoſed to be given) even as in Chapter 16. you found both thoſe by the Declination and Reclination given.

Example. I would ſet a plain Parallel to the Horizon of *Jeruſalem*,

ſalem, to ſhew me what time the Sun Riſes and Sets there any day of the Year, and what Hour paſſeth at *Jeruſalem* at any time of our day. Firſt I ſeek by *Geographical Tables* or *Mapps* the Longitude and Latitude of *Jeruſalem*, and I find that *Jeruſalem* is removed Eaſtward from *London* in Longitude 47 degrees, and that the Latitude there is 32 degrees, or thereabouts. Therefore in the Rectangled Triangle P R O of Chapter 16. I have the angle P 47 degrees difference of Longitude, alſo the ſide P R the Latitude of *Jeruſalem* 32 degrees, and hence by the 4th Probleme of Rectangled Triangles Book 3. 6. I get P O 42. 30 minutes, and by conſequence O N 9. 45. minutes (becauſe P N is our Latitude) and I get alſo the angle O 51. 40 minutes. And theſe had, I get by the ſame Probleme in the adjoyning Triangle O N D, both D N 12. 05. degrees, the Complement of the Declination inquired, and the angle D 39. 23. Complement of the Reclination inquired. Wherefore I conclude that a plain which ſhall repreſent here the Horizon of *Jeruſalem* muſt Decline Eaſtward 77. 55. minutes, and Recline Northward 50. 37. minutes. Draw upon this plain the proper Hours of *Jeruſalem*, by Chapter 23. and know that when the Sun leaveth this plain ceaſing to inlighten the upper part of it, then he ſetteth at *Jeruſalem*, and look how many Hours and minutes the Sun ſetteth after noon in any Country, ſo many Hours and minutes he roſe before noon.

Chap. XXVI.

How other Circles *of the* Sphear *beſides the* Meridians *may be Projected upon* Dyals.

THe Projection of ſome other Circles of the Sphear beſide the Meridians though it be not neceſſary for finding the Hours, yet may be both an ornament to Dyals, and uſefull alſo for finding the Meridian, and placing the Dyal in his due Situation, if it be made upon a moveable Body, as ſhall be ſhewed Chapter 33.

The Circles fitteſt to be projected in all Dyals for thoſe purpoſes are the Equator with the *Tropiques* and other his Parallels; which may be accounted Parallels of Declination, as they paſs through equal degrees, as every 5th or 10th of Declination: or Parallels of the Signes, as they paſs through ſuch degrees of De-

clination as the Sun Declineth, when he entreth into any Signe, or any notable degree thereof; or Parallels of the length of the day, as they pass through such degrees of Declination wherein the Sun increaseth or decreaseth the length of the day by Hours or half-Hours.

Also the Horizon with his *Azimuths* and *Almicantars* are an ornament to Horizontal and Vertical Dyals; and are likewise usefull for projecting the Equator and his Parallels in all Dyals. My purpose is to be breif in this Treatise of the *Furniture* here following becaus I hasten to an end. I shall therefore think it sufficient if I shew you one way to furnish any Dyal with the Circles of the Sphear. Leaving you to devise others which I could have shewn.

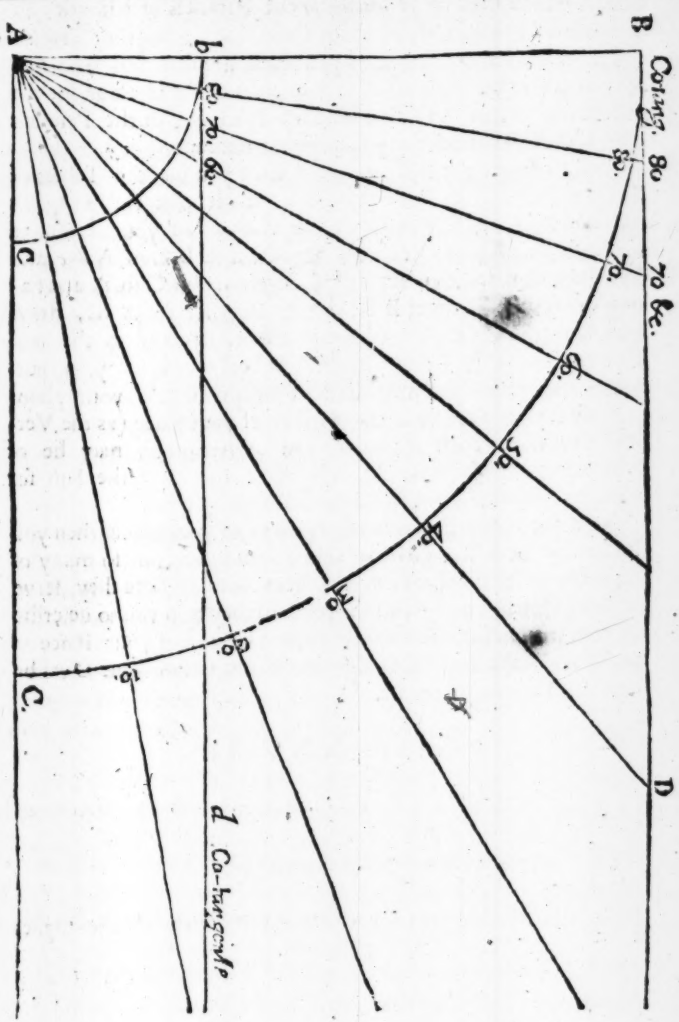
Chap. XXVII.

How to describe on any Dyal *the proper* Azimuths *and* Almicantars *of the* Plain.

FRom any point of the *Gnomon* (taken at pleasure) let fall a Perpendicular upon the Sub-style; that Perpendicular shall be part of the Axis of the plain, and shall be reputed *Radius* to the Horizon of your plain. The top of this *Radius* in the *Gnomon* is called *Nodus*, because you must there set a Knot Bead, or Button to give shade, or else cut there a notch in the *Gnomon*, or cut off the *Gnomon* in the Place of *Nodus*, that the end may give the shadow for those lineaments. Let not your *Nodus* stand too high above the plain, for then the shadow will fall beside your plain for too great a part of the plains day nor let it stand too low, for then the lineaments will run too close together. A mean must be chosen.

At the foot of this *Radius* take your Center, and describe a Circle on the plain and divide it into equal degrees; and from the Center draw lines through those degrees infinitely, that is, so far as your Dyal-plain will bear; these lines shall be the *Azimuths* of the Horizon of the plain, and shall be numbred from his Meridian or Sub style.

Divide any of these *Azimuth* lines into degrees, by Tangents agreeable to the said *Radius*, and having made a prick at every degree, through every of these pricks, you shall draw Parallel Cir-


A
B
b
Co-tang. 80
70 &c.
C
C.
D
d Co-tang. 80

Circles which ſhall be *Almicantars* or Parallels of Altitude, to be numbred inwards, ſo that at the Center be 90. for the *Zenith*, and from the Center outwards you ſhall number 80, 70, 60. &c. till you come within 10. or 5 degrees of the Horizon; for the plain is too narrow to receive his own Horizon, or the Parallels near, if the *Nodus* have any Competent Altitude.

And to divide the ſaid *Azimuth* lines you uſe the Tables of Tangents with a Scale of equal parts, or elſe plot the Tangents thus on paper, ſet A B equal to the *Radius* of your Horizon, and with that *Radius* draw the Quadrant A B C, or A *b c*, and divide the Quadrant, numbring the degrees from C to B, and having drawn the Tangent B D, or B *d*, Parallel to A C, draw lines from the Center through the ſeveral degrees to the ſaid Tangent-line, ſo ſhall this Tangent-line be divided for your purpoſe: and from it you may transfer the diviſions to your plain.

Now if your plain lie in the Horizon of your place, (as the Vertical plain doth) theſe *Azimuths* and *Almicantars* may be of ſome uſe to ſhew you the Altitude and *Azimuth* of the Sun for any time. See them in the Scheam Chapter 30.

But if your plain lie not in the Horizon of your place, then you ſhall draw the ſaid *Almicantars* or *Azimuths*, or ſo many of them as you ſhall need, in deleble lines, becauſe here they ſerve only the Horizon of the plain: yet ſhall they help you to deſcribe the Equator and his Parallels, with the Horizon of your Place in any Dyal: and when they have done this, unleſs your Dyal be Vertical, they may be gone.

Chap. XXVIII.

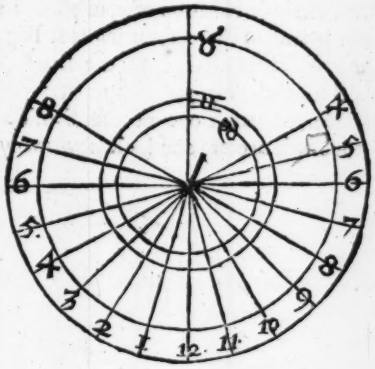
How by help of the proper Azimuths *and* Almicantars *of the* Plain *to deſcribe the* Equator *and his* Parallels, *on the* Polar *or* Orthognomonical Dyal.

IT ſhall ſuffice here to ſhew how the Parallels of the Signes may be deſcribed, becauſe the Parallels of Declination, and of the length of the day are deſcribed by like reaſon. And know that in the Polar plain becauſe the *Gnomon* is Perpendicular to the plain, the ſame *Gnomon* ſhall ſerve both Hours and *Azimuths*; for the Hour-lines be *Azimuths* in this plain. Note alſo

alſo that the Sun is never Elevated above this plain more then he Declineth from the Equator, which at the moſt is $23\frac{1}{2}$ degrees, and that if the height of *Nodus* be above a ſixth part of the Semidiameter of the plain, the ten firſt *Almicantars* will fall beſide the plain. A ſixth part therefore muſt ſerve, and that will give you all the Altitudes above 10 degrees, and the Parallels of the Signes whoſe Declination is more then 10.

Deſcribe therefore the *Almicantars* here, as you were taught Chapter 27. for in the Hour lines you have already every 15th *Azimuth*, and may draw more if you pleaſe.

Then know that the *Almicantars* here are the very Parallels of Declination, becauſe the Equator is the Horizon of this plain, and if you draw the *Almicantar* 11.30 minutes, that ſhall be the Parallel of ♈ or ♎ becauſe ſo much is the Suns Declination and alſo his Altitude above this plain, when he entreth thoſe Signes the *Almicantar* for 20. 13. minutes is the Parallel for ♊ and ♌ in like manner, and the *Almicantar* 23. 30. minutes the Parallel for ♋. And by like reaſon you may draw the Parallels of the South Signes on the South face.



Chap. XXIX.

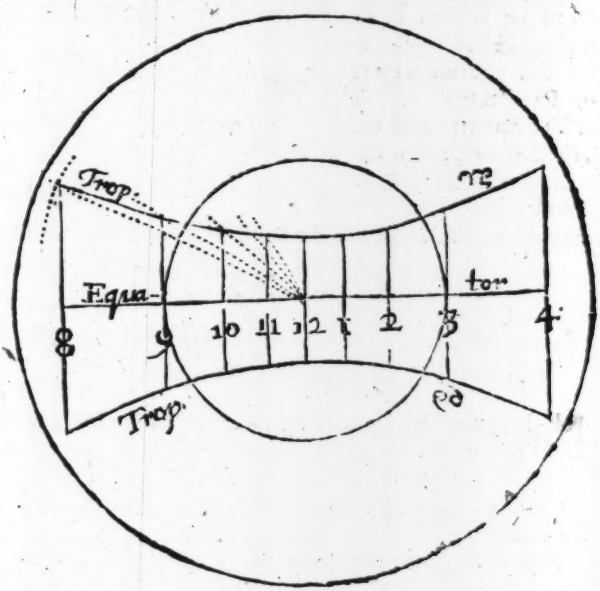
How to inſcribe the Equator *and his* Parallels, *in the* Equinoctial *or* Parallelognomonical Dyal.

IF this plain Decline not, the Hour lines of your Country will ſerve you for they be alſo the Hour lines of the plain, and the Noon-line is Sub ſtyle: if it do Decline, you ſhall draw in deleble lines the proper Dyal of the plain (by Chapter 23. which Declineth not.

And having here the *Azimuths* or *Almicantars* of the plain, drawn

drawn by Chapter 27. you ſhall obſerve upon your Planiſphear at what Altitude or at what *Azimuth* the Parallels cut the ſeveral Hour lines, and where the like Altitude or *Azimuth* cuts the ſame Hour lines upon the plain, you ſhall make marks, and through thoſe marks draw the Parallels which ſhall be all Conical ſections, except the Equator, which becauſe he is a great Circle, ſhall be a ſtraight line on thoſe plains; and in all other plains, except the Polar, where he is a Circle.

Now to find the Altitude and *Azimuth* which the Sun in ſuch a Parallel hath at ſuch or ſuch an Hour. Take the *Mater* in the Meridional Projection; only for this time let the *Limb* be not the Meridian of your place, but the 6 Meridian or Hour-circle, and likewiſe Horizon of your plain, and let the Axtree line be the Meridian thereof, cutting it at Right angles. Now look where the firſt Hour-circle from the *Limb* (which is 7 a Clock) interſecteth the *Tropique* of ♋, to that interſection you ſhall lay the *Label* (or rather one of the Semidiameters of the *Reet*, which toucheth neerer) and look how many degrees of the *Limb* lie be-



tween

tween the *Label* and the Equator line, ſo much is the *Azimuth* of that Hour from the Eaſt or Weſt in the *Tropique* of *Cancer*: and the degree of the *Label* cut at the ſame time by the *Tropique* and the Hour line is the Altitude ſought. Do ſo for the ſecond Hour circle, (which here is 8. and ſo for the reſt in order 9, 10, 11, 12. and you ſhall find that in the *Tropique* of *Cancer* in the Morning the Sun hath *Azimuth* from the Eaſt Northward, and Altitude as followeth,

	Azi. min.		*Alti. min.*	
7.	24.	20.	13.	44.
8.	36.	45.	27.	18.
9.	31.	30.	40.	25.
10.	40.	40.	52.	35.
11.	58.	30.	62.	20.
12.	90.	00.	66.	30.

In the Equator the *Azimuth* is always the ſame, full Eaſt or Weſt, and ſo upon your plain he muſt needs be a ſtraight line. The *Altitudes* in the Equator are 15, 30, 45, 60, 75, 90.

The Hours alike diſtant from the Meridian on both ſides are alike, and ſo are the Parallels alike diſtant from the Equator alike alſo.

When you have therefore gathered a Table out of your Planiſphear for the Morning Hours of the North Parallels, and of the Equator, (as I have done here in haſt for the Equator, and *Tropique* of *Cancer*) you may by that Table prick down the Parallels upon one quarter of your Dyal, and by that alſo draw the reſt; for as you may ſee upon your Planiſphear, all the 4. quarters are alike.

Note that the *Azimuths* cut the Hour lines too Obliquely: it is beſt therefore to truſt to the *Almicantars*, and ſo ſhall you have eaſier and ſurer work, though you meddle not with the *Azimuths* at all.

Chap. XXX.

How to inſcribe the Equator *and his* Parallels, *in an* Oblique *or* Scalenognomonical Dyal.

IF the plain neither Decline nor Recline, and ſo be a Vertical plain, the Hour lines of your Place will ſerve you, for they be alſo the Hour lines of the plain, and the Noon line is the

Sub-ſtyle. If it either Decline or Recline, or both Decline and Recline, you ſhall draw in deleble lines the proper Dyal of the plain by Chapter 23. and ſo this Dyal ſhall be reduced to a Vertical Dyal, and be as eaſily furniſhed with the Parallels as the Vertical: and when you have by the deleble Hour lines of the plain inſcribed the Parallels, you may wipe out thoſe Hour lines of the plain, and let the Hour lines of the place and the Parallels ſtand.

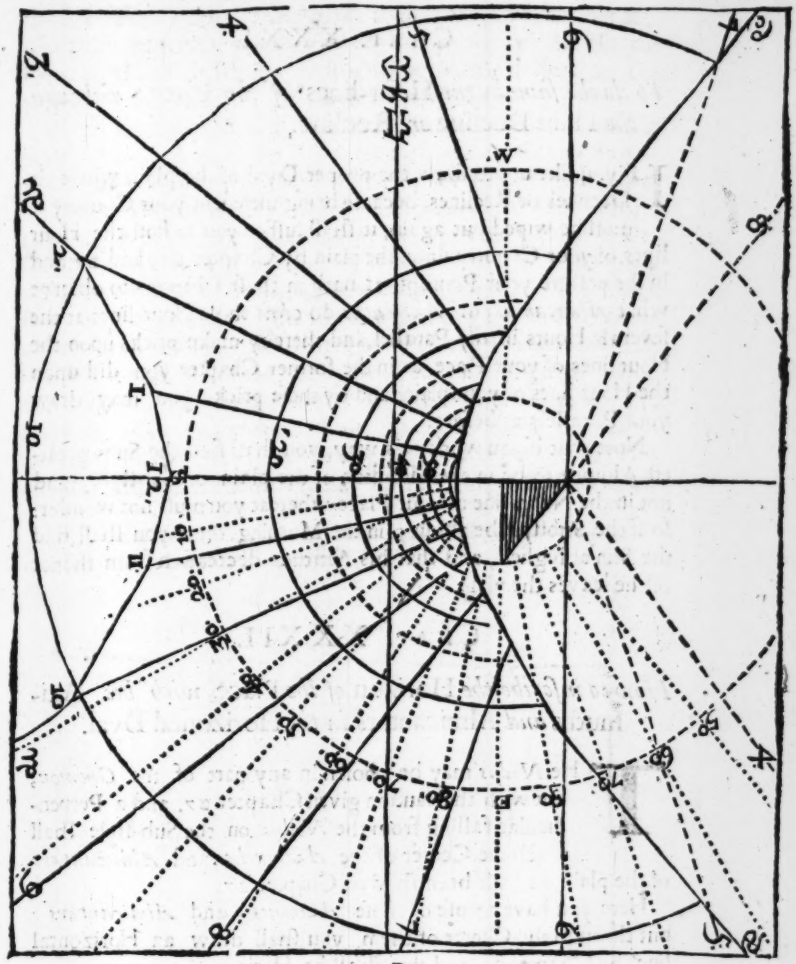
Having therefore drawn the *Azimuths* or *Almicantars* of your plain by Chapter 27. take your Planiſphear in the Meridional Projection, ſetting the *Finitor* to the Latitude of your plain; Then find your Equator and Parallels on the *Mater*, and where the ſeveral Hour lines interſect them above the *Finitor*, mark what *Azimuth* or rather what *Almicantar* paſſeth through theſe interſections; for in the ſame *Azimuth* and *Almicantar* ſhall the Parallels cut the Hour lines of the plain upon the plain.

Example. In the Vertical Dyal for our Latitude 52. 15. minutes, I ſet the *Finitor* to this Latitude, and going firſt to the *Tropique* of *Cancer*, I begin at the *Limb*, that is, at Noon, there I ſee the *Azimuth* full South, the Altitude 61. 15. minutes, at 1. a clock: *Azimuth* 27. *Altitude* 59. at 2. *Azimuth* 49 $\frac{1}{2}$. *Altitude* 53 $\frac{1}{3}$ at 3. *Azimuth* 67. *Altitude* 45 $\frac{1}{2}$. &c. Therefore where I find the Noon line of my plain cut by the *Almicantar* 61 $\frac{1}{4}$, I make a prick, and in the Hour lines of 11 and of 1. where the *Azimuth* 27 and the *Almicantar* 59 meet, I make pricks, and where the *Azimuth* 49 $\frac{1}{2}$ and the *Almicantar* 53 $\frac{1}{3}$ do meet upon the Hour lines of 10. 2. I make pricks, and ſo for the reſt.

Laſtly I draw with an even hand a crooked line without angles through thoſe pricks, and that ſhall be the Parallel or *Tropique* of *Cancer*: and in like manner I put in all the other Parallels, and the Equator in the midſt of them, though for the Equator you may draw him more ſpeedily by ſtriking a line through the Center of the *Almicantars* making Right angles with the Sub-ſtyle. And that may be a general Rule for the Equator in all Dyals which have a Subſtyle, and in the Polar Dyal where there is no Subſtyle, the Equator ſhall be a Circle, as before is ſhewn.

Note here that if your Dyal be great, and you have not points enough to govern you in the draught of the Conical ſections, you may draw half-hour-lines, and find points in them alſo, after the ſame manner.

CHAP.



Chap. XXXI.

To do the ſame by the Hour-lines *of the* Place, *although the* Plain Decline *or* Recline.

IF you like not to draw the proper Dyal of the plain where it Declines or Reclines, becauſe being uſeleſs in your Country, it muſt be wiped out again, it ſhall ſuffice you to find the Hour lines of your Country upon the plain, by Chapter 21, and 22 and in the poſture your Planiſphear hath in thoſe Chapters, to obſerve what *Almicantars* or *Azimuths* do croſs thoſe Hour lines at the ſeveral Hours in any Parallel, and thereby make pricks upon the Hour lines of your Place, as in the former Chapter you did upon the Hour lines of your plain; and by theſe pricks you may draw your Parallels as before.

Note that if you work this way, you ſhall find the Suns greateſt Altitude to be in the Meridian of the plain or Subſtyle, and not in the Noon-line of your Place; whereat you muſt not wonder: ſo if the Subſtyle be about 9 in the Morning, there you ſhall find the Sun at higheſt, and that his Altitude decreaſeth from thence till he leaves the plain.

Chap. XXXII.

How to inſcribe the Horizon *of the* Place, *with his* Azimuths *and* Almicantars, *in the* Horizontal Dyal.

THe *Nodus* may be choſen in any part of the *Gnomon*, but with the caution given Chapter 27. and a Perpendicular falling from the *Nodus* on the Sub-ſtyle ſhall touch the Center of the *Azimuths* and *Almicantars* of the plain, as hath been ſhewed Chapter 27.

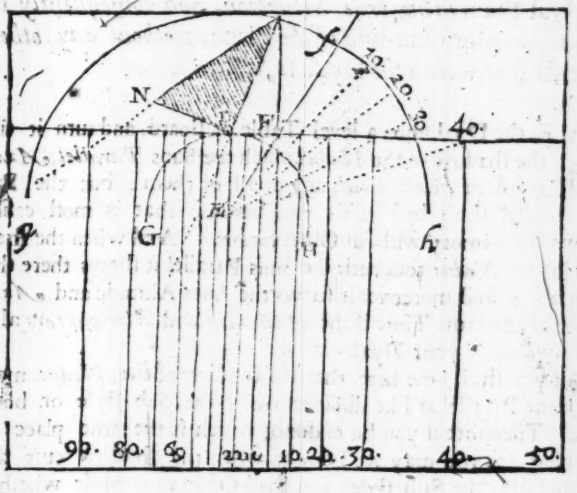
Here you have no uſe of thoſe *Azimuths* and *Almicantars*: but through the Center of them you ſhall draw an Horizontal line by Chapter 3. and that ſhall be Horizon.

Now if your plain Decline not from the Meridian, and ſo this Center fall upon the Noon line, you ſhall divide your Horizon both wayes from the Center, as you were taught to divide the *Azimuthal* lines by *Tangents*, Chapter 27. and ſhall number thoſe

those divisions from the Center on both sides 5, 10, 15, 20. &c. and from the several points so made for 5, 10, 15, &c. In the Horizontal line let fall Perpendiculars or Vertical lines on the plain, and they shall be *Azimuths* of your Place.

But if your plain Decline, you shall divide the Horizontal line thus. Draw a short Vertical line through the said Center downwards, by Chapter 3. which shall be the Verticle of your plain.

In that Verticle set D E equal to the *Radius* of the Horizon, (that is, D N the height of *Nodus*) and upon the Center E describe the arch G H or *g h* as wide as you please and the plain will bear; draw also through D the Horizontal line D F; then from the Center E strike the line E F *f* cutting the intersection of the Horizon with the Meridian of the Place at F and where the line E F cuts either of the said arches, you shall begin to divide either of them into fives or tens of degrees, numbring 5, 10, 15, &c. both wayes, and laying a Ruler from E to those degrees in the arch, you shall mark out thereby the same degrees in the Horizontal line, and from these marks let fall Perpendiculars upon



the plain, which shall be the *Azimuths* desired.

For the *Almicantars* they will not be so handsome lines, but if

you will have them, do thus. If the plain Decline not, ſet the *Finitor* to the Latitude of your Place, as Chapter 10. and if it Decline, ſet the *Finitor* to the Latitude of your plain as Chapter 21. Then keeping your ey above the Horizon, and within the *Tropiques*, mark what Hour lines the 10th *Almicantar* (for Example) cutteth, and what *Azimuth* there with him cutteth the ſame Hour lines alſo, and in the interſections of the ſame *Azimuths* and Hour lines upon your plain you ſhall make marks, through which the tenth *Almicantar* ſhall be drawn: and ſo of the reſt.

Note here That your *Azimuths* and *Almicantars* muſt not be drawn beyond the *Tropiques*, nor beyond the Horizon: neither muſt the Hour lines, if the *Nodus* be the end of the *Gnomon*.

The Scheam ſhews you how the *Azimuths* may be drawn on the Dyal of Chapter 12. and 21. Declining Eaſt 30 degrees.

CHAP. XXXIII.

How by the help of this Furniture to place any moveable Dyal-Plain *in his true Situation, and conſequently to find the* Meridian-line *of the* Place, *without any other* Inſtrument *then the* Dyal *it ſelf.*

SEt the Dyal upon a level Table or Board, and turn it till the ſhadow of the *Nodus* touch the Suns *Parallel*, *Azimuth*, or *Almicantar*, any or all of them: but the Parallel ſhall beſt guide you, becauſe that is moſt eaſily known by memory without Obſervation. And when the ſhadow of the *Nodus* toucheth the Suns Parallel it ſhews there the Hour alſo; and moreover it ſhews the Suns Altitude and *Azimuth* for the ſame Time if the *Azimuths* and *Almicantars* alſo be drawn upon your Dyal.

But you ſhall note here, that the ſhadow of the *Nodus* may touch the Parallel at like diſtance from the Sub-ſtyle on both ſides. Therefore if you be in doubt which is the true place of touching, (as you may well doubt when the ſhadow cuts the Parallel near the Sub-ſtyle) you ſhall Obſerve a while whether the ſhadow of the *Radius* be lengthning or ſhortning: If it ſhorten, the Sun is not come to the Sub-ſtyle, and ſo the earlyer Hour

Hour ſhewed is the true Hour; If it lengthen, the Sun is paſt the Sub-ſtyle, and the later Hour is the true Hour. And when the Dyal ſhews the true Hour, the *Gnomon* and the plains Parallel thereto do point North and South. And here you may ſee, that the further the Sun is from the Sub-ſtyle, the more eaſily is the Dyal placed.

Thus may you make a very commodious Polar Dyal, to ſtand in a chamber Window, and to remove from Window to Window as the Sun goes, which ſhall find the Meridian line it ſelf any where, in the 4. *Summer* and 4. *Winter* Moneths; and if you will make him a *Limb*, like the *Limb* of a Box-lid of a Cheeſe-fat, to receive the Parallels near the Equinoctial, which elſe fall beyond the plain, he ſhall ſerve for all the Year.

CHAP. XXXIV.

How to make a Vertical Dyal *upon the* Ceeling *of a* Floor *within Dores, where the* Direct Beams *of the* Sun *never come.*

THe greateſt part and as much as you ſhall uſe of the Vertical Dyal deſcribed Chapter 9. may by Reflection be turned upſide down, and placed upon a Ceeling, but the Center will be in the Air without Dores.

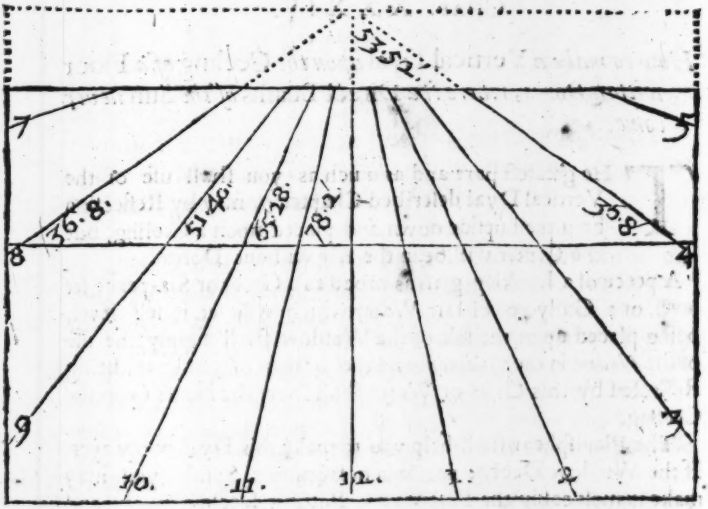
A peece of a Looking-glaſs as broad as a Groat or Six-pence ſet level, or a Gally-pot of fair Water, which will ſet it ſelf level, being placed upon the ſole of the Window ſhall ſupply the uſe of the *Nodus* in the *Gnomon*, and the beams of the Sun being Reflected by this Glaſs or Water ſhall ſhew the Hours upon the Ceeling.

The Planiſphear ſhall help you to make this Dyal two wayes. If the Window Decline not much from the South, you may make it moſt eaſily the Firſt way. But if it Decline much, and ſo the lines fall much upon the partition Walls, or if you would adorn this Dyal with the Parallels or other Circles, you ſhall uſe the Second way.

The Firſt way is this Draw a Meridian line upon the Floor, by Book 4. 3. ſo that it may point upon the Perpendicular, which you ſhall imagine to fall from the *Nodus* upon the plain of the Floor prolonged. And this may be moſt eaſily done, if you hang

hang a Plumb-line in the Window directly over the *Nodus* of place of the Glass, for the ſhadow which that Plumb-line gives upon the Floor at Noon, is the Meridian line ſought; and by a Ruler or a line ſtretched upon it you may prolong it as far as you ſhall need.

Then let a Plumb line fall from the Ceeling upon this Meridian line of the Floor, and behind it Northward or Southward, place your Ey, ſo that the Plumb-line may hide the Meridian line of the Floor from your Ey: then keeping your head ſteddy, caſt your Ey up to the Ceeling, and direct One to make two points at a good diſtance, in the line upon the Ceeling which the Plumb-line now covereth from your Ey, and by theſe points you ſhall draw a ſtraight Meridian on the Ceeling.



Then having faſtned one end of a Line at *Nodus*, let Another ſtretch this line up to the Meridian on the Ceeling, and let him move his hand nearer or further in the Meridian till you find by a Quadrant that this line pointeth up Northward as many degrees as the Elevation of the Equator is in your Country, and then you ſhall cauſe him to make a point where the line toucheth the

the Meridian of the Cieling, and through that point you ſhall draw the Equinoctial line of your Dyal, cutting the ſaid Meridian at Right angles. The length of the thred from the *Nodus* to the point in the Meridian where the Equinoctial cuts him, is *Radius* of the Equinoctial: to that *Radius* you ſhall find the *Tangents* of 15, 30, 45, 60, 75. as you found the *Co-tangents* Chapter 27. (knowing that the *Co-tangents* of 80, and 70. be the *Tangents* of 10, and 20. and ſo of the reſt) and beginning in the Meridian make pricks in the Equinoctial line, at the end of the *Tangent* of 15. Eaſtward for 1. and Weſtward for 11. and at the end of the *Tangent* of 30. prick Eaſtward 2. and Weſtward 10. &c.

Then by Chapter 9. ſeek what angles the Hour lines of a Vertical Dyal make at the Center, which in our Latitude are 1. 11. 58. minutes, 2. 24. 32. minutes, 3. 38. 20. minutes, 4. 53. 52. minutes, 5. 71. 17. minutes, and with the Complements of theſe angles ſhall theſe Hour lines croſs the Equinoctial: ſo the Hour line of 1. ſhall Incline to the Meridian on the South ſide the Equinoctial line, and ſhall make his leſſer angle with the Equinoctial 78. 02. minutes, and the reſt as in the Figure.

The Second way is this. Fit a plain ſmooth Board about a foot Square to lie level from the ſole of the Window inwards, and near the outer edge thereof make a Center in the board in the very place of *Nodus*, or a little under it, remembring that the *Nodus* or Center of the Glaſs muſt be ſet ſo much higher then this board, as the Center of your Quadrant is placed higher in the Projecting of the Dyal.

Upon that Center taken in the board deſcribe as much of a Circle as you may with the Semidiameter of your Quadrant; which Circle ſhall be Horizon: Draw here from the Center to the Horizon inwards a Meridian line, by Book 4. 3. and where it cuts the Horizon begin to graduate the Horizon into degrees of *Azimuths* both wayes, which you may ſpeedily do, by transferring the graduations of your Quadrant, or ſo much as you ſhall need, to this Horizon.

Next you muſt deviſe to make your Quadrant ſtand firm and upright upon one of his ſtraight ſides, (which I will call his foot for this time) and that you may thus do; Take a ſhort peece of a Ruler or ſmal Tranſom, and ſaw in one ſide of it a notch Perperdicularly, in which notch you may ſtick faſt or wedge the heel or the toe of your Quadrant, in ſuch ſort that his foot may come

cloſe to the board, and the other ſtraight ſide or leg may ſtand Perpendicular upon it.

Thoſe things prepared, put your Planiſphear in the Meridional Projection, with the *Finitor* at your Latitude, and firſt obſerve there the Altitudes of the Sun in the Meridian, which in Latitude 52. 15. minutes, you ſhall find in the *Tropique* of ♋ 61. 15. minutes, in the Equator 37. 45. minutes, and in the *Tropique* of ♑ 14. 15. minutes. Now having ſtuck a ſhort needle in the Center of the Horizon, cloſe to which you muſt alwayes keep the Center of your Quadrant, ſet the foot of your Quadrant in the Meridian line of the Board, and from the Center of your Quadrant extend a thred by 14. 15. minutes of Altitude ſtraight on to the Cieling (the thred only touching the plain of the Quadrant and making no angle with it, but held Parallel) and where the thred thus extended touches the Cieling make a point, then the Quadrant unmoved, extend the thred by 61. 15. minutes of Altitude, and make another point as before, and between theſe two points draw a ſtraight line, and that ſhall be your Meridian, and ſhall be long enough for your uſe: then extend the thred by 37. 45. minutes of Altitude, and where it touches this Meridian croſs the Meridian at Right angles with an infinite line, which ſhall be the Equator. Then ſeek upon your Planiſphear for one a clock, and you ſhall find in the *Tropique* of ♑ the Suns *Azimuth* 14. and his Altitude 13. 06. In the *Tropique* of ♋ his *Azimuth* 27½ and his Altitude 59. 04. minutes: therefore ſetting the foot of the Quadrant in the *Azimuth* 14. from the Meridian Eaſtward, I extend the thred by 13. 06. of Altitude, and make a prick in the Cieling: and again ſetting the foot of the Quadrant in *Azimuth* 27 ½. and extending the thred by 59. 04 minutes of Altitude, I make another prick in the Cieling, and the ſtraight line which I ſhall draw between theſe two pricks ſhall be all the Hour lines of One, and ſo of the reſt. And if you be minded to have the other Parallels drawn, you may find points for them as you have done for the *Tropiques*, and by thoſe points draw them. And note that two points made in the Cieling for the ſame Hour line in any two Parallels, or in the Equator and any Parallel, ſhall ſuffice to direct the line, though it is beſt to take your points in the *Tropiques*, at the largeſt diſtance, as I have here done, if there be room enough on the Cieling.

But becauſe it often happens that part of your Dyal falls beſide the

the Cieling, and the plain of the Cieling and of the Walls is often interrupted, and made Irregular by Beams, Wal-plates, Corniſhes, Wainſcot, Chimney-peeces, and ſuch like bodyes, I will ſhew you one abſolute device to carry on your Hour lines over all.

Extend the thred for any Hour line to the *Tropique* of *Cancer* in the Cieling, as you where taught before, and fix it there, and extend another thred in like manner to the *Tropique* of *Copricorn*; where ever it ſhall happen, (as perhaps beyond the middle beam, or quite beyond the Cieling upon the Wall) and fix that thred alſo. Then place your Ey ſo behind theſe threds that one of them may cover the other, and at the ſame inſtant where the upper line (to your Sight or Imagination) cuts the Cieling, Beams, Wall, or any Regular or Irregular body, above the end of the lower line, there ſhall the Hour line paſs from *Tropique* to *Tropique*: direct any By-ſtander to make marks as many as you ſhall need; and by theſe marks draw the Hour line according to your deſire.

If the arch of the Horizon between the *Tropiques* be within view of your Window, you ſhall draw the ſame on the Wall to bound the Parallels, the Horizons Altitude you know is nothing, and therefore he will be a level line; and the Suns *Azimuth* when he riſeth (commonly called *Amplitude*, and *Ortive Latitude*) is in *Cancer* 40. 40. minutes Eaſt Northward, and in *Capricorn* as much Southward; and theſe will be reflected to the contrary coaſts on the Dyal.

The end of the Fifth Book.

A breif Deſcription
Of a
CROSS-STAFF.

THe Croſſ-ſtaff conſiſteth of two Rules joyned (by a ſocket, or elſe pinned) in the form of a *Romane* T, and three Sights, or more.

The longer Ruler is called *Radius*, *Index*, and the *Yard*, as A B, of which I call A the neer end, B the further end. The breadth would be $\frac{3}{4}$ of an inch, the depth an inch and half, the length 70. or 80. inches: and every of thoſe inches would be divided by Parallels and Diagonal lines into 100. equal parts.

The ſhorter Ruler E F is called the Tranſom; it would be half an inch or three quarters, both in breadth and depth, and in length about 2. foot: for the Sights there, if I may adviſe you, would never be ſet above 20. inches aſunder.

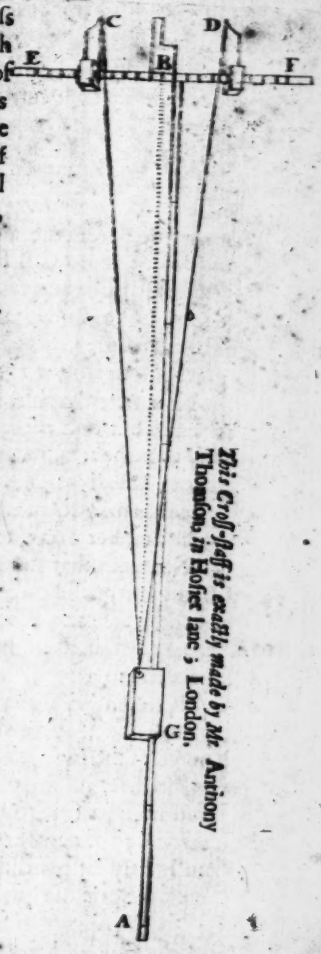
This Tranſom would be divided into whole inches onely, beginning in the midſt at B in the viſual line ⊙ B. and numbred to 10 both wayes.

The Sights C and D muſt have ſockets at the bottom, through which the Tranſom muſt paſs, ſo that the Sights may be ſet to any diviſion of the Tranſom. The Vanes or tops of thoſe Sights muſt have onely two edges on their ſides, viſible to your ey, namely thoſe edges which touch the Tranſom; and the two other edges muſt be pared away.

The middle Sight at B would have half his head cut away, and a ſhoulder left, as in the Figure, and a tenon at the bottom fitted to a morteſs made in the middle of the Tranſom, that you may ſtick him in and take him out when you pleaſe, for to this morteſs you ſhall do well to fit two other moveable Sights very narrow, for obſerving the Diameter of the Moon, or the diſtance of Stars which are very neer: one may be about half an inch broad, and the other about a quarter.

The Index muſt have one broad Sight, G ⊙, made with a ſocket to ride upon the Index; it would be three inches and an half

half high above the Radius: the breadth at leaſt three inches, and the mortes through which the Radius ſlippeth would be made neer the right ſide of the Sight, that full half of the Sights breadth (or more) may be on the left ſide the Radius. At the upper corner of this Sight leftward, as at ⊙, you ſhall with a Gouge hollow a pit for your ey, on the backſide: in the midſt of which pit you ſhall bore an hole quite through, big enough to receive a Gooſquill. alſo you ſhall round the corner of the Sight that it may fit the inner corner of your ey, that the left ſide of the Sight may lie cloſe to your Noſe in obſerving. The Fiducial edge of the middle Sight of the Tranſom muſt ſo anſwer this Ey-hole, that it keep the ſame diſtance from the ſide of the Radius leftward; and the diſtance would be about an inch and quarter, that your right Ey may eaſily come at the hole while the Index ſlippeth upon your right ſhoulder, and ſo your true Radius ſhall be the pricked line ⊙ B, running beſide the Index, but Parallel to it, and this line muſt cut the middle of the Tranſom, and the middle of his middlemoſt Sights.



When you would uſe this Staff, you ſhall firſt ſet the Sights of the Tranſom to like inches, as at 10, and 10. if the angle be great, or at 5, and 5. as in the Figure they are placed: alwayes ſet them at whole inches, and at like numbers on both ſides from the middle of the Tranſom: and chooſe to place thoſe Sights ſo that your Ey-ſight may be far diſtant from them in obſerving, for ſo you may the more diſtinctly obſerve the minutes and ſeconds of the angle inquired. Then reſting the further end of the Index upon a Wall

or ſome device fitted for that purpoſe, put the neer end over your right ſhoulder: and ſetting your Ey to the Ey-hole, ſlip the Index backward or forward till you ſee the objects by the ſides of the Sights of the Tranſom; and mark what number the back-ſide of the Ey-ſight cutteth upon the Index, for that ſhall give you the angle ſought in this manner.

Example. The Sights of the Tranſom being ſet at 5, and 5. that is, 10. inches aſunder, I obſerved two Steeples by their edges, and the Ey-ſight then cut upon the Index, 6625. that is, inches $66\frac{1}{4}$ from the Tranſom. I ſay therefore, As C B 500. to B G 6625. ſo C B Radius or 100000. to B G the Co-tangent of half the angle. Here I have no more to do then to divide 662500000. by 500. or 6625000. by 5. which is an eaſy work, and the Quotient 1325000. is the Co-tangent of 4. degrees 18. minutes 57. ſeconds 43. thirds, for half the angle.

Note here, that if the Sights had ſtood at 10, and 10. then had the number 6625. been the very Co-tangent of half the angle: and remembring that your Radius on the Tranſom hath but 1000. actual parts, go to the Canon, and cutting off ſo many places as may leave the Radius there but 1000. you ſhall find your number 6625. to be the Co-tangent of 8. 35 minutes.

Note alſo, that you may obſerve the angle between the middle Sight and one of the other: and then you find the Co-tangent of the whole angle to that Radius to which your Sight is ſet on the Tranſom, as to the Radius 200. 300. or any other even hundred to 1000.

Note further, that you muſt evermore obſerve neer the tops of your Sights, that the viſual lines may run above the Tranſom as much as the Ey is placed above the plain of it.

He that will, may have room to ſet ſeveral Scales of degrees and minutes to ſeveral Radiuſſes; as one to the Radius 300. another to 500. another to 700. by which the very degrees and minutes may be preſently had, without recourſe to the Tables. To me the Scale of equal parts is in ſtead of all.

The Commodities of this diſpoſition of the Staff, *are theſe.*

1. It is better managed when it reſts upon the ſhoulder, and the Ey-ſight being made to move while the Tranſom and his Sights ſtand Fixed, ſhall ſave you much labour of courſing up and

and down from one end of the Staff to the [illegible]er in obſerving.

2. The Ey-ſight being made to ſhew the angle by the length of the Co-tangents, ſhall alwayes give you large differences: inſomuch, that if your Staff be but 6. foot long you may obſerve to Seconds, and Thirds in leſſer angles, and till you come beyond 20. degrees, your Sight ſhall ſeldom move leſs then the tenth part of an inch for one minute. And beyond 30. or 40. degrees this Inſtrument would not be uſed, becauſe the Ey cannot ſee both the Sights of the Tranſom at once, without rolling from one to another, whereby the Center of Viſion is changed.

3. Your Ey is better fixed and ſhadowed by this Ey-ſight, then when the end of the Index is placed by gueſs upon the Cheek-bone.

The inconvenience here is no more then what is found in all Croſſ-ſtaffes of what form ſoever. And that is, they are ſubject to ſome errour by reaſon of the Eccentricity of the Ey. For the viſual Beams meet within the Ey at a depth uncertain, and they are alſo refracted in the Superficies of the apple of the Ey: the apple of the Ey alſo is not of the ſame convexity, nor of the ſame breadth in all Men: and it is contracted in a bright Air, and dilated in a darker Air; as you ſhall ſoon find if you go about to obſerve the Diameter of the Moon by this Inſtrument, without correction of the Eccentricity; for you ſhall alwayes find the apparent Diameter too great, and much greater in the Night, then in the Day. Thus, *November* 18. 1653. I obſerved the Moons Diameter 32. minutes 06 ſeconds in the Day Time, and that Night I obſerved it 58. minutes, by reaſon of the dilatation of the apple of my Ey in the Night.

This errour may be rectified two wayes. The Firſt is by examining the obſervations made with your Croſſ-ſtaff, by ſome other Inſtrument which is not ſubject to like errour. As for Example, I have deviſed to faſten an arch of a Circle containing 20. or 30. degrees to the end of a Ruler of 6. or 7. foot, and fit to it a *Label* with Sights, then having obſerved by my Croſſ-ſtaff the length of *Orions Girdle*, I will ſet my other Inſtrument to it, turning the arch toward me that I may manage the *Label* better, and noting the difference of the obſervations, I will find how to correct my Staff in that poſture an another time: and ſo by many obſervations I may frame a Table to correct the Eccentricity throughout: but my Table perhaps will not ſerve to correct

rect the eccentricity of every Mans Ey, neither will a Table made for the Night ſerve me in the Day.

The other way is moſt exact and certain for all Men. Make another Tranſom in all points like the firſt, but ſhorter by half, and let the diviſions thereof be into half-inches: this Tranſom muſt ride upon the Index with a ſocket, between the long Tranſom and your Ey. Now when you obſerve, ſet the Sights of the ſhort Tranſom to the like number of half inches as the Sights of the long Tranſom ſtand at whole inches, and when you have placed your Ey-ſight ſo that you ſee the Stars upon the edges of the Sights of the long Tranſom, draw your ſhort Tranſom till you ſee the Stars by his Sights in like manner at once; then look what number is cut by the ſhort Tranſom, the double thereof is the Co-tangent of the angle: and look what the number cut by the Ey-ſight wants of that double, ſo much is the Eccentricity of your Ey in that place. This way is ſhewed by that Excellent Mathematician Mr *Edward Wright* in Chapter 15. of his Treatiſe of Errours in *Navigation*.

FINIS.

A Catalogue *of* Eclipſes,

Obſerved ſince the Year of our Lord 1637.

FIrſt, At *Coventree*, whoſe Longitude is more Weſt then *London* 1. degree 29. minutes of ſpace, Latitude 52. 28. minutes. My eſpecial friends Dr *John Twyſden*, and Mr *Samuel Foſter*, late Profeſſor of *Aſtronomy* in *Gresham Colleige*, and my ſelf all together, obſerved the totall and great Eclipſe of the Moon, which hapned in the Year 1638. on *Tueſday December* 11. before Noon. The totall obſcuration began 1. hour 07. minutes: The time of emergence obſerved by the Altitude of *Benenaes* was 2. hours 41. minutes; ſo the totall Obſcuration continued 1. hour 34. minutes: during the greateſt part of which time the Moon was quite loſt, though the Skie was clear. When the Moon began to recoyer light ſhe was in the foremoſt foot of *Apollo*, between the two Stars of the third Magnitude: a line drawn between thoſe Stars did cut off the lower part of the Moons body to $\frac{1}{6}$ of her Diameter, and ſetting the diſtance of the Stars in 12. parts, the Moon had gone $7\frac{1}{2}$ of thoſe parts toward the Eaſterly Star: which is in *Calce Apollinis*. Hence I compute the apparent Longitude of the Moon at the time of emergence ♓ 29. 36. minutes 19 ſeconds, and her apparent Latitude 0. 44. minutes South.

2. At *Eaſton Macodit*, whoſe Longitude is Weſt from *London* 0. 43. minutes of ſpace, that is, almoſt 3 minutes of Time the Latitude 52. 13. minutes, *Anno Dom.* 1641. upon *Fryday October* 8. I obſerved the end of the totall Eclipſe of the Moon, when *Lyra* had Altitude 48. 48. minutes, that is, at 8 hours 38. minutes 08. ſeconds after Noon.

3. At *Ecton* whoſe Longitude is Weſt from *London* 45. minutes of ſpace, or 3. minutes of Time Latitude 52. 15. minutes, *Anno Dom.* 1645, upon *Munday Auguſt* 11, I obſerved the Eclipſe of the Sun ending when the Center of the Sun was in *Azimuth* 0. 55. minutes paſt the South, that is, 0. hours $2\frac{1}{2}$. minutes after Noon. This Eclipſe *Hevelius* obſerved to end at *Dantzick* at 1. hour 53. minutes, as he writes in his *Selenographia*.

4. At *Ecton* aforeſaid, *Anno Dom.* 1649. upon *Wedneſday May* 16. before Noon: I obſerved in the company of Mr *Samuel Silleſby*, late *Fellow* of *Queens Colleige* in *Cambridge*, the totall Eclipſe of the Moon. The beginning when the right *Knee* of *Ophiucus* was in *Azimuth* 7. 42. minutes paſt South: that is, 1. hour 08. minutes *a. m.* The totall obſcuration began when the *Azimuth* of the ſaid Star was 20. degrees Weſtward, that is, at 1. hour 55. minutes 44. ſeconds. By the *Medicean* Tables it ſhould happen to be totally obſcured at *Uraniburg* 2. hours 46. minutes 23. ſeconds, and at *Ecton* 1. 53. minutes 23. ſeconds. By *Lantsbergius* Tables, at *Ecton* 1. hour 40. minutes 48. ſeconds.

5. At *Ecton*, *Anno Dom.* 1649. *October* 25. current, Afternoon, I obſerved by a *Teleſcope* the Eclipſe of the Sun. The Digits Eclipſed and the Time were as followeth,

Dig.	*H. min ſec.*	*Dig.*	*Hour.*
0. $\frac{1}{8}$	0. 41. 56.	4.	1.47.28.
1.	49. 48.	3.	2.03.28.
2.	59. 44.	2.	15.32.
3. —	1. 09. 44.	1.	22.40.
4.	26. 12.	0.	31.04
4. $\frac{1}{8}$ —	33. 32.		

the South Eaſtward.

6. At *Eaſton Macodit Anno Domi.* 165$\frac{1}{2}$. on *Munday March* 15. in the Morning, I obſerved with Dr *Twyſden*, that the Moon was Eclipſed about one Digit when *Alkair* was in *Azimuth* 79.40. minutes from More we could not ſee for Clouds.

7. At *Ecton Anno Dom.* 1652. on *Munday March* 29. before Noon, I obſerved the great Eclipſe of the Sun by a *Teleſcope* and a minute-watch Rectified by the *Azimuth* of the Sun, taken both before and after, in the company of half a ſcore Gentlemen and Miniſters my Neighbours, as followeth.

Di. mi.	*Ti. mi. ſec.*	*Digits. Time*
0. 03. —	9. 21. 12.	11.00.-10.35$\frac{1}{2}$
1. 00. —	9. 27.	10.00.-10.42$\frac{1}{2}$
2. 0. —	9. 31. 08.	9.00.-10.48$\frac{1}{2}$
3. 0. —	9. 37.	8.00.-10.55.
4. 0. —	9. 44.	7.00.-11.01.
5. 0. —	9. 50.	6.00.-11.06$\frac{1}{2}$
6. 0. —	9. 55.	5.00.-11.11$\frac{3}{4}$
7. 0. —	10 00.	4.00.-11.19.
8. 0. —	10. 06$\frac{1}{2}$	3 00.-11.24$\frac{1}{2}$
9. 0. —	10. 11. 28.	2.00.-11.31.
10. 0. —	10. 18.	1.00.-11.35$\frac{1}{2}$
11. 0. —	10. 25.	0.00.-11.42$\frac{1}{2}$
11. 22$\frac{1}{2}$ —	10. 32. 04.	

And though this Eclipſe was ſo great, yet we could read in the

the time of the greateſt darkneſs within Dores, notwithſtanding that the Window was covered with a Blanket.

8. At *Eſton*, *Anno Dom.* 1652. on *Tueſday September* 7. current, the Moon roſe Eclipſed about 10. Digits, and while 8. Digits were yet darkned all the dark part of the Moon was viſible of a Dusk and Tawny colour: this Eclipſe ended when the double Star in *Cornu* ♈ wanted in *Azimuth* 6. 30. minutes of the South; that is, at 7. hours 51. minutes 52. ſeconds: but the Moon was not free of the *Penumbra* till 7. minutes after.

9. At *Eſton*, *Anno Dom.* 1654. on *Wedneſday Auguſt* 2. current, before Noon, I obſerved the great Eclipſe of the Sun by a *Teleſcope* and a Minute-watch, ſufficiently Rectified by the *Azimuth* of the Sun, in the company of many learned Men my Neighbours and friends, as followeth.

Di.	*T. mi.*	*Di.*	*Time.*
0.—	7. 47.	$10\frac{1}{4}$-	
1.—	7. $52\frac{1}{2}$	10.-	9. 00.
2.—	7. $58\frac{1}{2}$	9.-	9. 09.
3.—	8. 04.	8.-	9. 18.
4.—	8. 09.	7.-	
5.—	8. 15.	6.	9. 31.
6.—	8. $20\frac{3}{4}$	5.	9. 38.
7.—	8. 28.	4.	9. $45\frac{1}{2}$
8.—	8. 34.	3.	9. $51\frac{1}{4}$
9.—	8. $40\frac{1}{2}$	2.-	
10.—	8. 49.	1.-	10. $03\frac{1}{2}$
$10\frac{1}{4}$—		0.-	10. 09.

10. At *Eſton*, *Anno Dom.* 1654. on *Thurſday Auguſt* 17. I obſerved the Eclipſe of the Moon by a *Teleſcope* and a Minute-watch, Rectified by the *Azimuth* of the firſt Star in the Horn of ♈, as followeth,

Time After Noon.	*mi.*	
9.	$47\frac{1}{2}$	I ſaw the *Penumbra* invading the Moon, with my bare Ey.
9.	54.	I ſaw the *Penumbra* invading through my *Teleſcope*.
10.	$15\frac{1}{2}$	Shadow 3 minutes deep.
10.	25.	Shadow 4. minutes deep Yet I could diſcern all the *Limb*.
10.	45.	Shadow more then 4. minutes deep. Yet the Moons *Limb* all ſeen.
11.	05.	Yet the darkneſs is more on the Eaſt ſide: ſhadow is 5. minutes deep, and the *Limb* is loſt in the ſhadow.
11.	11.	All the *Limb* ſeen again, and the ſhadow ſeems but 3. minutes deep, and juſt under

Time After Noon *mi.*

the Moon ſo that the Eaſt and Weſt ſide of the are darkned alike.

11. 22. The ſhadow little above 1. minute deep in my Glaſs.

11. 25. The ſhadow half a minute deep by my Glaſs.

11. 27. The ſhadow gone in my Glaſs: But the *Penumbra* ſtill covers almoſt $\frac{1}{3}$ of the Moons Diameter.

11. 30. The ſhadow is here gone in the judgement of my naked Ey, but the *Penumbra* is ſeen ſtill.

11. 35. The Moon as clear as at 9. 47 $\frac{1}{2}$. but yet the lower quarter of the Moon is much dusker then the reſt of her body.

11. At *Ecton*, *Anno Dom.* 1658. upon *Tueſday January* 1. afternoon, I obſerved the Eclipſe of the Moon, by a Minute-watch Rectified by the Southing of the Stars. Clouds often hindred, but thus I obſerved.

Ho. mi.

6. 43 $\frac{1}{2}$ The Moon growes dusk on the Eaſt ſide.
49 $\frac{1}{2}$ More dusk, yet all the *Limb* is ſeen.
51 $\frac{1}{2}$ Here I judge the Moon to touch the *Umbra*.
53 $\frac{1}{2}$ The *Limb* begins to be loſt in the ſhadow ſo far as I can diſcern both with the *Teleſcope* and without it.

7. 00 $\frac{1}{2}$ ☽ darkned 2. Digits by eſtimation.
07 $\frac{1}{2}$ Almoſt 4. Digits.
34 $\frac{1}{2}$ Almoſt 7. Digits: here the Clouds thicken.

8. 29 $\frac{1}{2}$ ☽ darkned about 10. Digits, yet almoſt all the Moon is perceivable through the ſhadow.
36 $\frac{1}{2}$ About 10. Digits, yet almoſt all the *Limb* perceivable.

9. 11 $\frac{1}{2}$ About 8 Digits.
23 $\frac{1}{2}$ About 5 $\frac{1}{2}$ Digits.
28 $\frac{1}{2}$ About 4. Digits.
39 $\frac{1}{2}$ About 3. Digits.
51 $\frac{1}{2}$ Here I judge the end. The *Limb* of the ☽ is all reſtored, yet the Weſt ſide of the Moon looks duskiſh for 3. or 4. minutes longer.

12. At *Ecton*, *Anno Dom.* 1657. on *Munday June* 15. the Moon

Moon roſe Eclipſed: I obſerved the end thereof by the *Azimuth* of *Antares*, to be 16. minutes after 10.

13. At *Eſton*, *Anno Dom.* 1657. on *Thurſday December* 10. I obſerved the Eclipſe of the Moon ending, when ſhe was apparently 34 degrees high, and me thought I diſcerned the *Penumbra* till her Altitude 35. it was a thick flying miſt, no Star but *Jupiter* could be ſeen with us all the time of this Eclipſe: about one third (at the moſt) of the Moons Diameter was darkned on the North ſide. From the firſt Ecliptical oppoſition mentioned in this *Catalogue* to this laſt is the ſpace of a *Metonique* Year.

Theſe Obſervations are faithfully reported, as I made them. I could have ſtrained ſome of them to a better *Harmony*; if I would have forged any thing, or uſed my own judgement upon them: but I rather leave them to the judgement of the learned Readers; eſpecially ſuch as have accuſtomed themſelves to Celeſtial Obſervations.

FINIS.

The Rudiments of *Astronomy*, Put into plain *Rhythmes*.

The Constellations of the Fixed Stars.

THe Army of the Starry Skie
Declares the Glory of God most high;
Seen and perceived of all Nations
In eight and fortie Constellations.
First neer unto the Northern Pole
The *Dragon* and two *Beares* do Role.
Whose hinder parts and Tailes contain
The lesser and the greater Wain.
The *Hair*, the *Bear-ward*, and the *Crown*,
And then comes *Hercules* kneeling down.
And next below a place doth take
Great *Serpentarius* with his *Snake*.
Under the *Harp* of *Orpheus*
The *Eagle* and *Antinous*.
The *Silver Swan* her Wings doth spread
Above the *Dart*, and *Dolphins* head.
Then *Pegasus* comes on amain;
Andromeda followes in her Chain.
The Triangle below her stands;
And at her feet in *Perseus* hands
The *Gorgons* Head. Above are seen
Her Parents *Cepheus*, with his Queen
Cassiope. Not far below
Heniochus his *Goat* doth show
On his left shoulder: in his hand
He doth the stormy *Kids* command.
Here in the *Zodiaque* begins
The *Ram*, the *Bull*, the Loving *Twins*;
The *Crab*, the *Lion*, and *Virgin* Tender,
The *Ballance*, *Scorpion*, and *Bow bender*;
Goat, *Waterman*, then *Fishes* twain
Shall bring you round to th' *Ram* again.
Fifteen Images appear
In the *Southern Hemisphear*.
The Monstrous *Whale* before the rest,
Eridanus scarce wets his brest:
Over the *Hare Orion* bright
Sparkles in a Winters night.
Then comes the great *Dog*, at whose tayl
The famous *Argo* spreads her sayl.
Above the little *Dog* doth flame,
For whom the *Latines* had no name:
Long *Hydra* on her tail alow
Carries the *Pitcher* and the *Crow*.
The *Centaure* holds the *Wolfe* by th' heel.
The *Altar*, and *Ixions* Wheel
Are never seen of us: but here
The *Southern Fish* brings up the rear.

The Planets.

UNder those fixed Stars above
Seven *Planets* in their *Orbes* do move.
The high'st is *Saturn*. Thirty Year
He spends in Compassing his *Sphear*.
Twelve *Jupiter*, and *Mars* in twain
Sets forward and comes round again.
Then in one Year the *Sun* displaies
Three hundred sixty and five dayes,
And near a quarter; which in four
Encompassings makes one day more.
Between the *Sun* and us there fly
Fair *Venus*, and swift *Mercury*.
These alwayes near the *Sun* we find;
Not far before, nor far behind.
The *Moon's* the lowest, who in seven
And twenty dayes goes round the Heaven.
And above two dayes more do run
Before she overtakes the *Sun*.
So twenty nine and an half in all
Do make a Moneth *Synodical*.

These

These *Planets* make their course to th' East,
Though they be faster hurled West.
And six degrees the rest may stray
Beside the *Suns Ecliptique* way,

The Circles of the Sphear.

SIx greater Circles mark you shall
Which equally divide this Ball.
Just in the midst between the Poles
From East to West th' Equator rolles.
Th' *Ecliptique* cuts him; and doth slide
Scarce twenty four degrees aside.
Horizon even with the ground
From Stars below our sight doth bound.
Meridian upright doth rise,
Parting the East and Western Skies.
Two Colures through the Poles do run
Quartring the Circle of the *Sun*.
One where the *Spring* and *Fall* begin,
Th' other where longest dayes come in.
Four lesser Circles (mark them well)
Are to th' Equator Parallel.
Two *Tropiques* bound the *Suns* high way
Shewing the Long'st and Shortest day,
The *Arctique* Circle cuts the *Beares*,
Th' *Antarctique* opposite appeares.
Meridians half twenty four
For Hours, and for Degrees ninescore,
Through both the Poles oth World do pass,
And th' Equinoctial down right cross.
And ninescore Parallels hath that line
By which Stars North and South decline,
Th' *Ecliptique* hath his Longitudes,
And *Parallels* of Latitudes
For Stars: but in *Geography*
The Towns beside th' Equator lie.
Over our Head, and under Feet,
The ninescore *Azimuths* do meet.
And here as many Parallels
Of Altitude Horizon tells.
Longitudes, and Meridians all,
And *Azimuths*, great Circles call.
But all their Parallels in Heaven,
Being lesser, cut the Globe uneven.
Degrees three hundred and threescore
Hath every Circle and no more.

When I consider thy Heavens, the work of thy Fingers, the Moon and the Stars which thou hast ordained, What is Man that thou art mindfull of him? Or the Son of Man that thou visitest him. Ps. 8.

Errata.

Some Faults have been committed between the Writer and the Printer; the cheif whereof the Reader is desired to amend as followeth.

pag. and *line.*	*Faults*	*Amendments.*
2, 3, 4. &c. to pag. 30. in the Title	*The first Book of the Fabrique of the* Planisphere.	*The first Book. Of the Fabrique of the* Planisphear.
31 and 32. in the Title	*The second Book of the Projections of the* Sphear.	*The second Book. Of the Projections of the* Sphere.
1. 13.	mossie	massie.
2. 7. / 3. ant.	Declination	Delineation
4. 16.	look up	look upon
4. 36.	eye beam	eye-beame
5. 13.	Euclid. 4, 5.	Euclid 4. 5.
22.	required of your Compass over reach	required. If your Compass reach short
5. 23.	if it reach short	if it over-reach
6. 39.	structures	structure
8. secant 67.	25693.	25593.
The 5. last Tangents want a place.		You must add a Cypher to each of them.
9. 16.	two	so
12. 18.	all but	all. But
13. 07.	working it	working. It
16. 19.	foure	fewer
17. 18.	*Alamath*	Alamach
21.	Henerichus	Heniochus.
17. antop.	*little vain*	little Waine
18. 8.	brow	Crowne
18. 30.	Præcepe	Præsepe
19. 16.	Bedalgieure	Bedalgieuze
23.	Alhaber	Alhabor.
20. 6.	round the inner circle or edge of this Ring it must	round. The inner circle or edge of this Ring must
20. 14.	naile screwes	male screwes
17.	small screwes	female screwes
19.	bare	beare
22. 30.	is made and gon, for that year: your scale	is made. And so for that year your scale.
24. 9.	but one degree	but for one degree
25. 7.		put out the marks of Parenthesis( )
26. 8.	year *Henr.* 3.	year of *Henr* 3.
23.	Periodas	Periodus
28.	alwayes, upon	alwayes upon
35.	thus, set	thus set
28. 1. and 5.	Grostons	Graftons

pag. and lin.	Faults.	Amendments.
30. 3	second Meridional	second, or the Meridional
33 6.	see for *London*	namely for *London*
33. 21.	on Elevation	no Elevation
34. 1.	with the	which the
9.	Azimuth	Azimuthes
37. 6.	the eyes place	the eye is placed
41. 3.	Center B A,	Center, B A
48. 4.	either; way.	either way;
22.	A C	C A
50. 16.	Zenith, of	Zenith of
32.	Zenith and B	Zenith A and B
53. 12.	12 and 13 nnmber	12th and 13th numbred
56. 8.	these sides	the sides
20.	subtendeth A	which subtendeth A
62. 17.	fall	falls
63. 7, 9.	wayes	rayes
ult.	of	deleatur
64. 10.	min. at 70	min. and at 70
11.	between 8 degr. 34. min.	between 18 and 24 min.
12.	Here Refraction is as the Sun	Her Refraction is as the Sun's
65. 1.	your Meridians	your Meridian
66. 30.	require	enquire
67. 3.	*Michal.*	*Michael.*
68. 39.	Long	long
73. 6	CHAP. II	CHAP. XI.
74. 20.	} Alrucabe	Alrucaba
75. 8.		
75. 12.	first made	first mode
76. 29.	prick here	prick; here
81. 16, 17.	by Declin.	by their Declin.
82. 12.	her Declin.	his Declin.
antep.	sta	Star
86. 16, 17, 18, 19.	Pleiades { Riseth / setteth	Pleiades { Rise / set
86. 30.	to be least	to be lost
87.	ἀνθρώπους	ἀνθρώποις
88. 4.	could happen	could not happen
14.	note	know
17.	*Aſera*	*Aſera*
91. 1.	Duct.	Deut.
99. 21.	23 degrees	23^{d} degree
102. 6, and 30.	*Eniph. Alph.*	*Eniph Alph.*
23.	$35\frac{1}{3}$	$56\frac{1}{3}$
105. 8.	Stars, I	Stars, I
)	*Ceti*	*Ceti*
19.	120 deg.	125 degr.
110. pen.	by Oblique Problemes	by Probl. 2 Obliqu.
111. 25.	in $39\frac{1}{2}$	in all $39\frac{1}{2}$
114. 17.	grees setting,	grees. Setting
11.	Houses: also	Houses also

pag. and line.	Faults.	Amendments.
	31. 49, 30	50, 51.
118.	6, 7. 49, 50	50, 51.
	24. and ſo	and to
119.	1. Aſtrologers	Aſtrologie
	17. *futurus*	*futura*
122.	29. no man	no men
123.	3. *princeps. Nero*	*princeps Nero*
	4. *citheræ*	*citharæ*
	10. *dereliquit. Nero*	*dereliquit Nero.*
	12. *perſueſum*	*perſuaſum*
	27. *ſe nore*	*temerè*
128.	26. as by	and by
	29. ſetting go	ſetting therefore
130.	34. Jupiter in that Meridian;	Iupiter. In that Meridian
139.	6. Chriſt time	Chriſts time
	17. *Ticius*	*Tacitus*
141.	6. 4, 5. 11.	4. 5, 11.
145.	13. Suns Dyals	Sun Dials
147.	5. or Equinoctial	deleatur
	19. ſo the hourlines	to the hour-lines
154.	in the ſcheam the letter I is wanting at the lower end of the hour-line of 11.	
157.	17. with an extenſion	with any extenſion
174.	32. *precrucem*	*per crucem*
176.	11. by the arch	by R T the arch
180.	9. Declination plain	declining plain
181.	20. *pre*	*per*
184.	27. the Vertical of my Dial, and alſo	deleatur
185.	28. and ſo	and to
188.	9. *Tumiture*	furniture
190.	7. you uſe	you may uſe
192.	in the ſcheme, the prickt line laſt ſave one ſhould be put out.	
193.	*ant.* a Vertical plain	a Vertical or a South Horizontal plain
194.	27. of 10. 2	of 10 and 2
199.	11. Box-lid of a	Box-lid or of a.

Alſo many words are miſ-written, As Cannon for Canon. Letteſs for Latteſs. Finiter for Finitor. Semediameter for Semidiameter, Trygonometry for Trig. *Ophiucus* for *Ophiuchus*. *Plaiades* for *Pleiades*. Acronically for Acronychally, Aſcendant and Deſcendant for Aſcendent and Deſcendent. *Equinoctiorum* for *Æquinoctiorum*. examplification for exemplification, Dyal for Dial. Ceeling for Cieling &c, which the Reader is deſired to amend or overlook: as alſo the miſ-placing or omitting of points of diſtinction, as Comma's Colons and Periods, which I could not prevent, being ſo remote from the Preſs. Many of theſe miſtakes are here corrected in the Table of Errata: eſpecially the moſt material.

The

The Contents

of the First Book.

The Contents

Of the Second Book.

The Contents

Of the Third Book.

The

The Contents

Of the Fourth Book.

The

The Contents

Of the Fifth Book.

34. *How*

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